POWER

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Horse Power per Man Power a Measure of Modernism

SINCE the maximum number of producers in the world is always less than the maximum number of consumers, we have the economic law, as inevitable as any other law of nature, that only by increased productivity per worker may we increase the average standard of living.

Mechanical devices, so-called "labor-saving" machinery, and above all the substitution of mechanical power for human effort, all increase human productivity. It is evident, therefore, that the greater application of power is almost invariably an indication of advance in industry. As a unit by which we may measure this advance, we can well take the relationship between the horse power of generating equipment used to the man power employed. In other words we may well say that every increase in horse power per man power represents a modernizing tendency of industry. Unfortunately, data are not available by which we can measure each industry accurately with respect to this unit. But each establishment within any industry may well take this unit into account. It affords the best measure of progress which industrial management can have of this important relationship.

Simple Methods of Determining Dissolved Gas Content in Boiler-Feed Water

By J. R. McDERMET* and DANIEL WERTHEIMER †

THE laboratory of the Elliott Co. has developed to a high stage of technique, methods for the determination of dissolved gas content of boiler-feed water. Dissolved gases, and in particular oxygen, have become of significance with the advent of high steam pressures and superheats as dangerous accelerators of corrosion in boilers and economizers. Control of this corrosion depends primarily on knowledge of dissolved gas content. The following methods seem to the writers the simplest and easiest to apply. Photographs of the actual apparatus are shown, so that the reader may cheaply assemble the necessary parts with the aid of a chemical glassware catalog. Fig. 1 illustrates the set-up for Reichardt's method of boiling out and measuring the dissolved gases directly. At the beginning bottles *A* and *B* and adapter *C* are filled with water and the water boiled free from air by gentle heating with flames under the bottles. Bottle *A* contains a definite volume to the lower line of the stopper, below which the glass delivery tube does not extend. The dissolved gases are expelled from *C* by steam from *A* and withdrawn through the pinch cock. Bottle *B* is included to compensate with air-free water for changes in the volume of the contents of *A* and *C* in the boiling process. The delivery tube in *B* extends completely to the bottom. Another tube extending through the stopper of *B* is provided to vent steam from *B*. Where several determinations are to be run consecutively, it is useful also in refilling *B*, by siphon action on cooling, with water that has been made partly air-free by boiling over a flame. At the conclusion of the boiling-out process the flame is removed from *A*, and bottle and delivery tube are allowed to fill with water from *B*. The pinch cock in the delivery tube is then closed so that the tube will remain full of water when bottle *A* is subsequently removed. Bottle *A* is then removed refilled with water to be tested, and the stopper replaced to the definite volume mark, care being taken that no air bubbles are retained in the top of the bottle. The pinch cock in the delivery tube is then opened and the boiling continued until all the dissolved gases in the sample collect in *C*. This usually requires about thirty minutes.

By the methods described no special laboratory glassware is necessary; the operator need not be a chemist or have had laboratory experience.

When all the gases are collected in *C*, it is connected to the water-jacketed gas burette *D* and the gases are withdrawn. Burette *D* and its leveling bulb may be filled either with mercury covered over its meniscus surface with non-volatile oil or with a saturated salt solution. It is impossible to prevent some water being drawn over from *C*, and unless such precautions are taken in selecting the confining liquid in *D*, considerable reabsorption will take place when this water cools to the temperature of the jacket water. At the end of about fifteen minutes the gas will have attained the temperature of the jacket water, and its volume may then be read directly from the burette scale by bringing the level of the liquid in the leveling bulb to the precise height of the liquid in the burette. This burette volume may be calculated into standard volume from the temperature of the burette jacket water and the barometric pressure.

Some steam is always drawn into the burette along with the dissolved gases. This condenses in a film on the surface of the burette inclosing the gases, and for precise work it is necessary to correct the barometric reading for the aqueous tension at the temperature of the jacket water. The vapor pressure of the concentrated salt solution, when it is used, may ordinarily be neglected. With such waters it is necessary to employ Lenossier's method, which also is a chemical means of determining dissolved oxygen. The phenosafranine indicator employed in this method is not so decisive in its color change (red to straw color) and has an appreciable lag in its indications, but from the standpoint of apparatus and manipulation the method is indeed attractive. Separatory funnel *A*, Fig. 2, of about 500 c.c. capacity is filled with about 400 c.c. of mercury

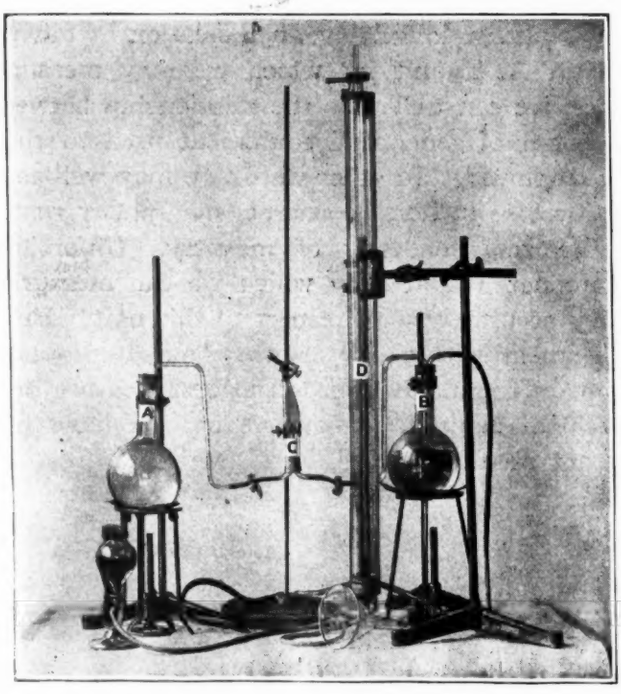

FIG. 1. APPARATUS USED IN REICHARDT'S METHOD OF BOILING OUT DISSOLVED GASES IN WATER DIRECTLY

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and the balance with water to which has been added 20 c.c. of sodium-hydroxide solution (36 deg. Bé.), 20 c.c. of rochelle salt (20 per cent), and a few drops of an alcoholic solution of phenosafranine (1 in 2,000). The two-hole stopper is then replaced, the burette *B* filled with a standard solution of ferrous sulphate (O2N) and sufficient sample poured into the 125-c.c. graduated separatory funnel *C*. After the apparatus is found airtight, ferrous sulphate is added to the water in *A* to absorb all the oxygen. This is accomplished by opening the stop cock of burette *B*, permitting the mercury in funnel *A* to run out drop by drop. After additions of every few drops of ferrous sulphate all stop cocks are closed and the solution well shaken to cause diffusion of the ferrous sulphate. The whole apparatus is arranged on a stand to facilitate this shaking, and the mercury is put in solely for this purpose. When neutralization is established, the stop cock of *B* is closed, stop cock of *C* opened, and a measured volume of the water sample run in, the volume being read from the graduations on funnel *C*. With the addition of the oxygen the mixture in *A* turns red again, and neutralization with ferrous sulphate is accomplished as before. In this case the volume of ferrous sulphate, as given by the burette readings before and after the addition, is a measure of the amount of oxygen in the volume of the sample added. The process of alternate additions and titrations may be repeated indefinitely as long as there is sufficient mercury in *A* to accomplish the mixings. It is possible to calculate oxygen directly from the volume and normality of the ferrous sulphate, but it is desirable to calibrate it from determinations made by the Winkler method on a sample free from nitrates and nitrites. Experimentally, the results from Lenossier's method are strictly consistent and fairly accurate, but the results calculated from normality, etc., of the ferrous sulphate are likely to be high. The method is to be regarded as useful only where the Winkler method is inapplicable.

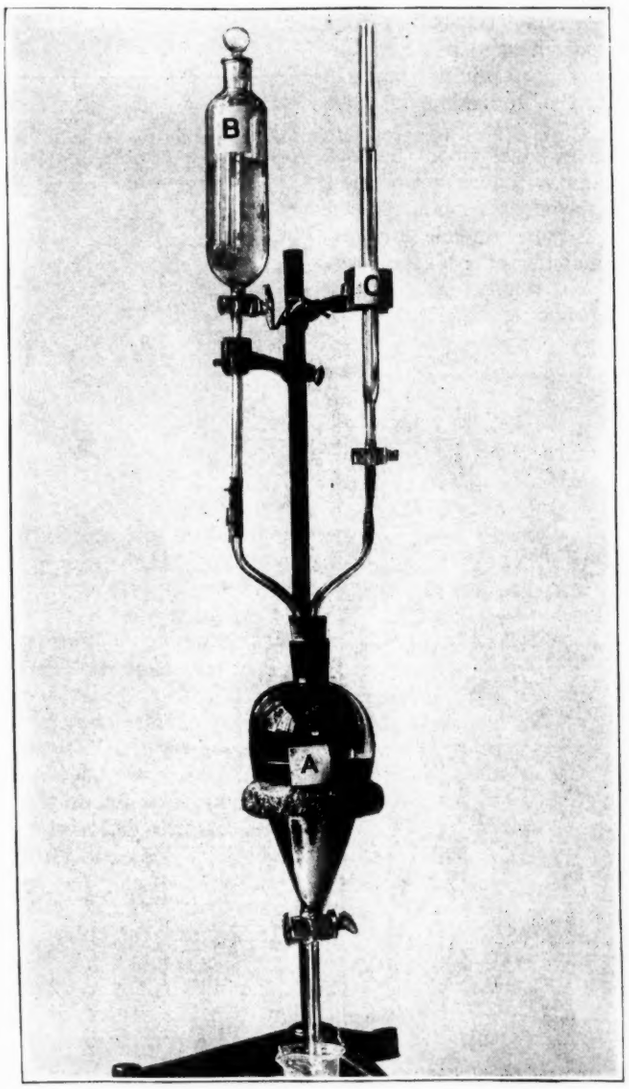


FIG. 2. SEPARATORY FUNNEL FOR DETERMINING OXYGEN CONTENT IN WATER

In the application of any of these methods to samples from which air has been partly removed, it is necessary to emphasize that preliminary to testing, the greatest precautions must be taken to avoid contact with air and particularly agitation. This method is desirable only because of its simplicity. It is the least accurate of the three and calls for constant and painstaking attention in its performance, but it requires no special knowledge of chemistry or high degree of laboratory technique.

The Winkler chemical titration method for the determination of dissolved oxygen is considered by the writers as the best of the three methods discussed. Its advantages lie in the following:

1. Minute traces of oxygen may be determined with the highest degree of accuracy and rapidity, by an operator having had only a few hours' experience.
2. The method gives the determination directly in terms of dissolved oxygen, which is the significant factor in corrosion due to dissolved gases.
3. No special pieces of glass apparatus are required, and the apparatus may be readily assembled in kit form for field use. The field kit is shown in Fig. 3.

The solutions required are: (a) Manganous chloride (400 parts in 1,000 parts water); (b) alkaline iodide solution (700 parts sodium hydroxide and 150 parts potassium iodide in 1,000 parts water); (c) sulphuric acid (equal volumes conc. acid and water); (d) starch indicator (1 part starch paste in 400 parts boiling water); (e) sodium thiosulphate solution, approximately 0.025 normal. This solution should be prepared and standardized by a competent chemist or bought already prepared from a chemical-supply house. It is unstable if kept for long periods, so purchases should be limited to about two months' supply.

The method is briefly as follows: To a 500-c.c. sample of water 4 c.c. each of manganese-chloride solution, alkaline iodide solution and sulphuric acid are added in the order mentioned. To permit diffusion of the reagents, the additions are made at two-minute intervals. This procedure results in the liberation of iodine in the sample in exact proportion to the original amount of dissolved oxygen present in the water. The solutions are most easily added by means of 4-c.c. suction pipettes which are filled to the calibration mark on the stem by suction applied with the lips. The last two solutions are, respectively, caustic and acid, and

therefore care should be taken that none of these liquids comes into the mouth. Special precaution must be taken not to disturb the water until after the addition of sulphuric acid.

A 250-c.c. sample of this treated water is then taken and a few drops of starch indicator added. This colors the solution a beautiful blue. The liberated iodine is then titrated with sodium-thiosulphate solution by adding it drop by drop from a calibrated burette until the blue color disappears. The difference of burette volume readings before and after the addition of the thiosulphate is the measure of dissolved oxygen. In samples heavily saturated with oxygen the iodine color of the sample should be partly discharged by the addition of the thiosulphate before the starch indicator is added. The color change of the indicator is both sensitive and decisive.

The chemistry of the method is based upon the fact that iodine is liberated in the sample in exact proportion to the amount of oxygen dissolved. A standardized solution of sodium thiosulphate is merely a solution containing a definite calibrated amount of sodium thiosulphate per unit volume. Each volume then has a definite capacity for dissolving iodine, and it is possible to eliminate consideration of intermediate reactions and calculate oxygen directly from volume of thiosulphate solution.

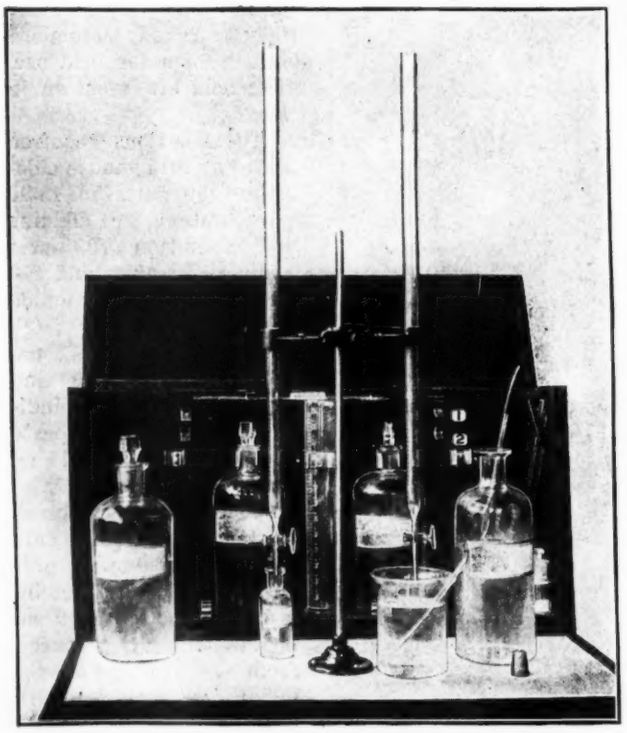


FIG. 3. FIELD KIT USED FOR WINKLER METHOD OF TITRATION FOR DISSOLVED OXYGEN IN WATER

$$\text{Oxygen (c.c. per liter)} = \frac{139.5N \times A}{V\ 0.0025}$$

in which N = number of cubic centimeters of thiosulphate used in titration; V = volume of solution titrated; and A = normality of thiosulphate solution.

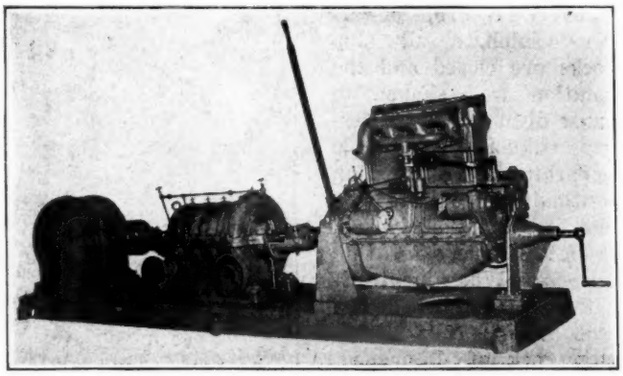
If it is desired to know the volume of air dissolved, it is possible to determine it from the oxygen content by comparisons with a solubility table.

Unfortunately, the Winkler method is inaccurate for waters containing either organic nitrates or organic and inorganic nitrites.

Water has the greatest avidity for redissolving air, and therefore methods of collecting samples represent in many cases more of a problem than the actual determination of dissolved gas content.

Midwest Pumping Set

Of late years water-works engineers, to insure a constant service, have installed many gasoline-engine-driven centrifugal pumps. The pumping set here represented consists of an electric motor direct-connected to a four-stage Midwest centrifugal pump manufactured by the Midwest Engine Co., Indianapolis, Ind. To the other side of the pump is fitted a 40-hp. Midwest four-cylinder gasoline engine. The pump is ordinarily driven by the electric motor. In event of failure of the electric power, the engine is started and clutched to the pump. In this manner constant service at the water station is assured. In many localities this combustion will allow a lower insurance rate. The engine is of the four-cylinder valve-in-the-head type, having a bore of 4½-in. and a 6-in. stroke.



MIDWEST PUMPING SET

Diesel-Engine Pointers

In aligning the bottom shells of oil-engine main bearings, the thickness of each shell should be measured at the ends and center. If one bearing has worn thinner than the others, it should be shimmed up or the others scraped down.

Most oil engines run best with 0.004 to 0.006 in. clearance between the shaft and the top bearing. To secure this, lead wires can be used to check the clearance.

If the crankshaft has an endwise movement, the ends of the bearing should have babbitt rings run on them; steel washers placed between the crank throws and bearings are equally good. If not corrected, the sidewise movement will bell the crankpin bearings.

If a main journal or crankpin gets roughened the scores can be removed by careful filing and lapping with emery compound.

If a babbitt lining shows evidences of being cracked, it should be removed and rebabbitted at once.

After rebabbitting a bearing, it should be bored true before scraping, in order to preserve the alignment of the shaft and bearing.

Protective Relays—Reverse-Power Type

By VICTOR H. TODD
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Conditions produced in a system of parallel feeders when a short-circuit occurs are discussed and then types of reverse-power relays that will operate under these conditions are considered. Both single-phase and polyphase relays are treated of.

A REVERSE-POWER relay's function is to isolate trouble on a system of parallel alternating-current feeders. The most common use of the reverse-power relay is shown in Fig. 1, where alternator *A* is connected to a bus *B* which supplies a sub-bus *C* over the parallel feeders *D* and *E*. If a short-circuit occurs at *X* on feeder *D*, power will not only flow from

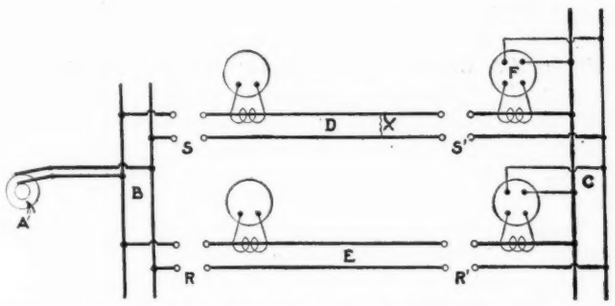


FIG. 1. PARALLEL FEEDERS CONNECTED BETWEEN A MAIN AND A SUB-BUS

B over *D* into the defect, but it will also flow from *B* over *E* to sub-bus *C* and back to the fault *X*. Therefore to isolate the fault it will not only be necessary to open switch *S* at bus *B*, but also switch *S'* at the sub-bus. Switch *S* can be tripped with a relay, having a definite-time setting; however, in order to open switch *S'* before switch *R* can open a reverse-power relay is required that is set for a shorter period than the time-limit relay at *R*. To develop a satisfactory reverse-power relay for the protection of parallel alternating-current feeders has always been one of the most difficult protection problems. It might appear, at first thought, a very easy matter to place contacts or a wattmeter which would hold open on normal direction but close on reversal of power. However, should the short be near the substation the voltage will be very low, although the current may be high, and the power actuating the wattmeter will be extremely low in this case. In fact, some tests made, in which the line was actually shorted intentionally, show that the voltage may drop as low as 1 per cent of normal. Furthermore, we are dealing with three-phase current, and phase distortions must be considered, particularly in the case of short-circuits from one line to the ground, or on one phase only. These short-circuits may so distort the relation of current to voltage as to cause the angle between them to be almost 90 deg., thus producing the worst condition for low torque in the wattmeter element; namely, very low power factor and voltage.

One of the first relays used for reverse-power tripping had a wattmeter element which closed contacts. In this form the movement was the same as the induction wattmeter. There was a movable arm and contact and two stationary contacts, one on each side of the movable contact, with separate adjustments provided to allow different setting for tripping points in normal and reverse directions. The movement was controlled by a strong spring to allow setting to two or three times full load. No attempt was made to introduce time lag or damping, the relays acting instantly. These relays were found to be entirely inadequate on account of insufficient torque when short-circuits cause the voltage and power factor to drop to low values. They proved conclusively that a pure "wattmeter" relay was not satisfactory.

A practical reverse-power relay should fulfill the following conditions:

1. It should close its contacts positively when the direction of power flow is reversed, under all possible conditions of voltage, power factor and current.

2. It should never, under any circumstances, close its contacts when the direction of power flow is normal.

These are the fundamental requirements. In addition it is desirable to have a time element that can be accurately predetermined and quickly adjusted to any desired value. It is assumed as a matter of course that the relays are reliable and rigid in their mechanism and have the necessary current-carrying capacity both in windings and contacts. A most important step toward fulfilling these conditions was in adding a separate wattmeter element with contacts in series

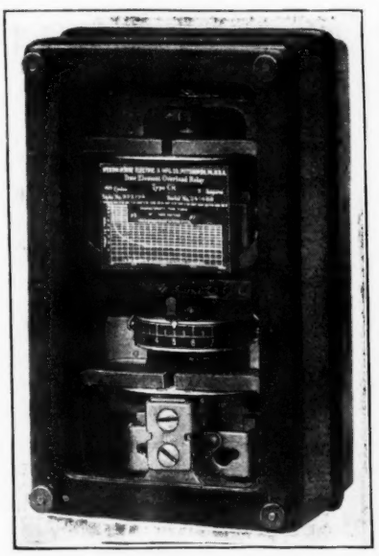


FIG. 2. SINGLE-ELEMENT TYPE REVERSE-POWER RELAY

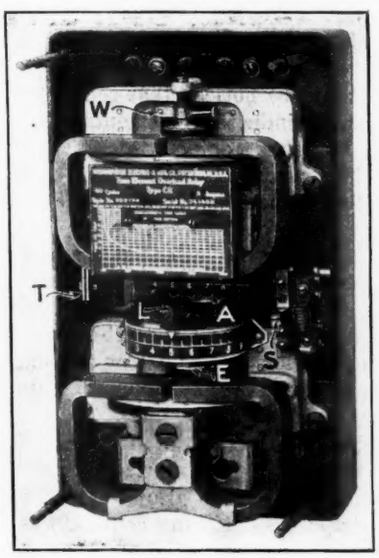


FIG. 3. THE SAME AS FIG. 2, WITH COVER REMOVED

with those of the excess-current relay. The wattmeter element was very carefully constructed, with a weak spring and quick-time element, so that the least flow of current in the normal direction would hold the contacts open and prevent the excess-current relay from tripping the breaker, even in the event of overload. Should the power reverse the wattmeter element quickly close its contacts, but since they were in series with the excess-current relay contacts the breaker could not trip until both closed; that is, an excess current in the reversed direction. This combination clearly selected between an overload in the normal and reverse direction even if the voltage dropped to 2 per cent of normal and the power factor to 10 per cent. This reverse-power relay as finally developed contained two separate elements; a plain excess-current relay, and a sensitive reverse-watts relay with their contacts in series. This allows the current to be set high enough so that it will not operate

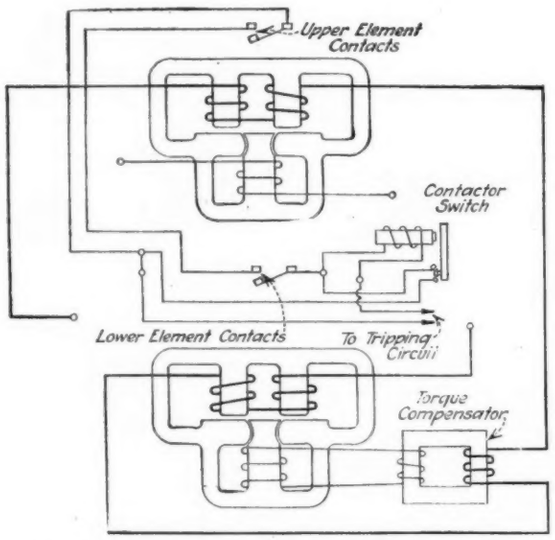


FIG. 4. DIAGRAM OF RELAY CIRCUITS, FIG. 2

except on excess current in either direction, but still the reverse-watt element insures that the breaker can never trip except when the excess current is in the direction of reverse power.

In Figs. 2 and 3 is shown a reverse-power relay of the foregoing type. This relay combines all the points heretofore mentioned. It will be noticed that the single case contains two separate induction elements, each with its windings, disc, magnets, contacts, etc. There is no mechanical connection whatever between the two moving elements. The top element is the quick-acting, sensitive watt element with a contact switch *W* controlling the contactor *S*. The lower element is a standard "excess-current" (overload) relay, provided with an adjustable time lever *L*, current-adjusting plate *A*, excess-current contacts *E* in series with the watt-element contacts *W*, torque compensator *T*, etc. The wiring diagram, Fig. 4, gives the internal connections, the current winding being shown by the heavy lines.

Owing to the flow of heavy currents the vibration of the discs prevented the making of good contacts at the watt element and the excessive torque also caused the discs to slip on the shafts. The fluttering contact was changed into a positive one by means of the contactor switch shown at *S*, Fig. 3. This consists of an electro-magnet *A*, Fig. 5, capable of attracting an iron armature *B*, which is pivoted at *C* and carries a silver contact *D*. The contacts *E* are those on the lower-element relay contacts shown in Fig. 4. When contacts *E* close and are vibrating or chattering owing to the heavy induced currents in the disc to which they are attached,

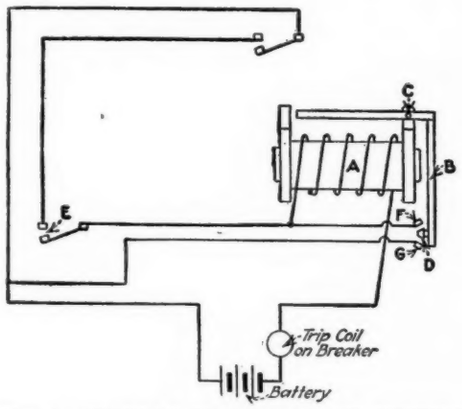


FIG. 5. DIAGRAM OF RELAY TRIP CIRCUITS

their partial touching allows a small current to flow in the solenoid *A*, Fig. 5. This weak current causes the solenoid to attract the armature *B*, and causes *D* to short-circuit the two contacts *F* and *G*, thus positively energizing the trip coil and tripping the breaker. It is evident that should contacts *E* still flutter there will be no spark. In fact, the first touch is enough to close *D* and trip the breaker. The trip circuit will stay energized and contact *D* closed until the circuit is opened by the auxiliary pilot switch on the breaker, which is arranged for this purpose. The contactor switch not only assures positive contact, but increases the tripping-circuit capacity from two to ten amperes, thus avoiding the use of an auxiliary relay switch except in the case of very heavy trip currents.

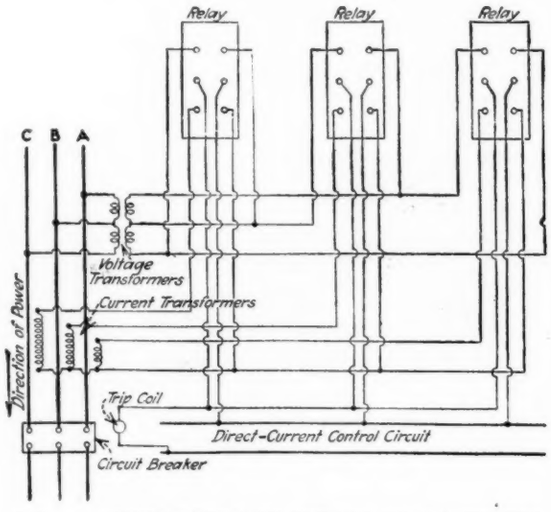


FIG. 6. CONNECTIONS OF RELAYS TO CAUSE THE CURRENT TO LEAD THE VOLTAGE ON NON-INDUCTION LOADS

Excessive torque is overcome by means of the "torque compensator," which is a small transformer, Fig. 4, with the primary winding carrying the main current,

the secondary supplying the relay windings. The compensator is so proportioned that the iron becomes saturated at heavy overloads, thus preventing excessive flow of current in the relay.

In view of the fact that the heavy overload currents produce such strong fields it might be suspected that this alternating field would weaken the permanent magnets and change the time setting. This, however, is not the case, as the magnets are placed on the diametrically opposite side of the disc from the driving coils, and thoroughly shielded by the framework, exactly as in an integrating wattmeter. Moreover, in testing, the relays are subjected to many times more current than they would ever get in actual practice, so any demagnetizing effect would make a permanent change the first time the relay was tested and following excess current could not change its action.

The most important requirements of a reverse-power relay is that it should operate when the potential at its terminals is between 1 and 2 per cent of normal. If we assume the case of a No. 0000 cable normally carrying 300 amperes at 12,000 volts connected to a generating station having a short-circuit current of 3,000 amperes, the loss which would occur between the busbars and a metallic short-circuit 100 ft. from them would be 45 kw. per phase, or less than three-quarters of one per cent of the relay setting.

The statement has frequently been made that a reverse-power relay cannot operate when there is no voltage, but neither can there be a flow of current unless there is a difference of potential. The problem is, therefore, nothing more than a question of securing a

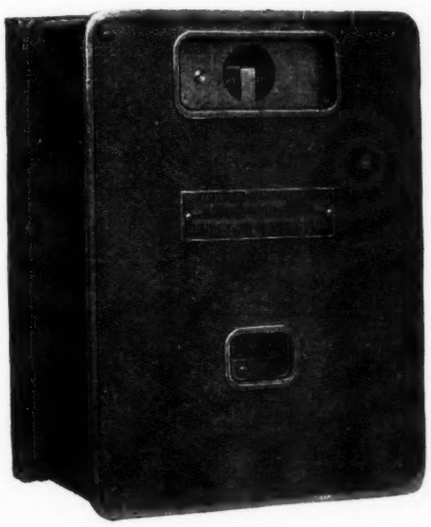


FIG. 7. RELAY HAVING THREE REVERSE-POWER ELEMENTS

contact-making wattmeter which is sensitive to operate on the small potential that is always present when a short-circuit occurs. Numerous tests have been made that show that when a cable breaks down the arc through the insulating space between conductors will maintain a voltage of between 1 and 2 per cent, and it has been found that a higher voltage is maintained when the current is small than when it is excessive—a fact that materially assists reverse-power relays. It should be pointed out that on large systems it is practically impossible to obtain a metallic short-circuit, because any small object that could be brought into contact with the busbars would be immediately destroyed.

In the past the operation of reverse-power relays has been somewhat unsatisfactory because means were not taken to insure correct operation at times when the power factor of the system was bad owing to unbalanced short-circuits. As a result of several years' investigation it has been found that the method of connecting reverse-power relays with their potential coils

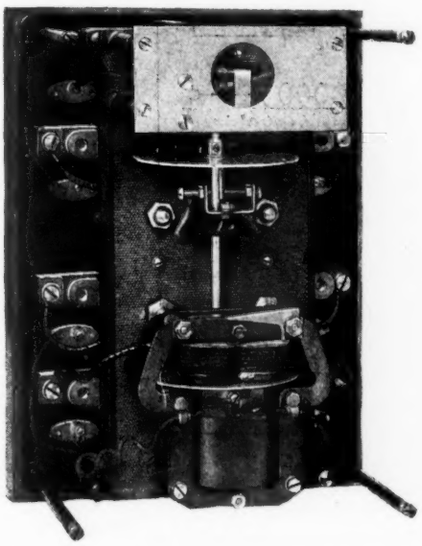


FIG. 8. SAME AS FIG. 7 WITH COVER REMOVED

in star, as has been the usual custom, is theoretically incorrect, and the relays will fail to operate upon the occurrence of the most common form of short-circuit. When unbalanced short-circuits occur a large number of combinations of circumstances are possible, but it has been found that the most severe condition is when only two conductors of a three-phase line are short-circuited, and if relays will operate properly under this condition they will satisfy practically all other.

One method of taking care of the distorted condition in the system due to a single-phase being short-circuited is to connect the relay's voltage coils across the same conductors that are causing the short-circuit. In other words, the voltage coils are connected in delta in accordance with Fig. 6. Because the current will lag behind the voltage when a short-cirucit occurs by practically 90 deg., the connection should be so made that at unity power factor the current in the current coils of the relays will lead the voltage by 30 deg. This connection not only overcomes the trouble from distortion, but it allows the relays at all time to operate under a higher power factor. In order to make this connection satisfactory it is necessary to take into account the direction of the rotation of phases.

There are two very simple methods of determining the correct connection. One is to connect the current coils of a single-phase power-factor meter in series with the relay-current circuit and then, with 100 per cent power factor load on the line, select the pair of voltage leads that give about 86 per cent power-factor lead on the meter. The second method is to use a single-phase indicating wattmeter and, with a lagging power factor load on the line, select the pair of voltage leads that

give the highest reading. Just after making this test is the proper time to see that the contacts are held open. If they close the voltage leads must be reversed. The foregoing discussion is not based solely upon the mathematical study of the problem, but is the result of actual tests made on a number of systems where the reverse-energy relays connected according to the old method have not given satisfactory service. Experiments have shown that this method of connection should also be used on systems having a grounded neutral. This connection (with the current 30 deg. ahead of the voltage) must be used with care on an ungrounded - neutral system having a heavy charging current to ground. Difficulty may also be encountered on some systems where the load current is leading. But in both these cases the lagging short-circuit currents will be much greater than any possible leading current and no difficulty due to incorrect operation of the reverse-power relays will be experienced if the excess-current elements operate on short-circuits only.

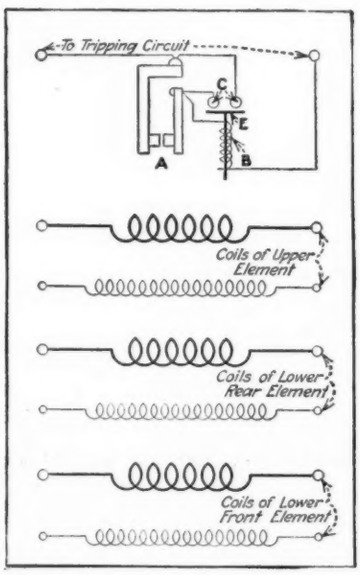


FIG. 9. INTERNAL CIRCUITS OF RELAY, FIG. 7

To insure satisfactory protection on a grounded-neutral system current transformers should be placed in each wire, and it is advisable to do the same on an ungrounded-neutral system. This is because two conductors in different phase of different sections of line are likely to be grounded simultaneously, thus resulting in a short-circuit which involves two lines. For instance, suppose that phase *A* in one section of line becomes grounded and the resulting surge in voltage causes a breakdown in phase *B* in another line. If both of these wires should happen to be without current transformers the short-circuit could not be cleared.

Two voltage transformers connected in open delta are sufficient to operate three reverse-power relays. On high-voltage systems it is sometimes inconvenient to connect voltage transformers on the line side of the power transformers, in which case they may be connected to the low-tension bus, but if the high-tension transformers are connected star-delta then the voltage transformers must be connected the same way to preserve the correct phase relations.

Instead of combining a watt-element and an overload relay in one case and using three combination instruments on each three-phase line some engineers prefer to house the three watt-elements in one case and use this relay in conjunction with two or three overload relays, of either the plunger or the induction type. Such a relay is shown in Figs. 7 and 8, and the internal wiring diagram in Fig. 9.

From Fig. 9 it will be seen that there are three separate current coils and three potential coils, and since the relay operates on the induction principle there is no mutual inductance between coils; consequently, no induced voltage in the potential coil from the heavy current flowing in the series coil. Two discs are used, the upper one of which is driven by one element. The lower disc is driven by two elements, one in the front, shown in Fig. 8, and one in the rear. Under normal direction of power the discs tend to rotate to the right and keep the contacts open. Reversal of power flow causes the discs to rotate to the left, thus closing the contacts; no attempt is made to dampen the movement and the arc of disc travel is very small.

Fluttering trip currents such as might be due to vibration of the disc, bouncing of contacts, etc., are overcome by means of the auxiliary switch at the top of the figure. When the main relay contacts *A* first make contact the solenoid *B* is energized, which quickly forces *E* against contacts *C*, thus relieving the current from switch *A*. Once closed, however, they stay closed until the trip circuit is broken by an auxiliary switch which operates when the circuit breaker opens.

This reverse-power relay must be used in conjunction with a three-phase on three single-phase overload relays, such as the induction type of solenoid-bellows type, to secure proper protection. Each overload relay's coil is connected in series with a current coil of the reverse-power relay. Complete connections for a three-phase circuit are given in Fig. 10. The main three-phase line is protected by a circuit breaker and supplied with three current and three voltage transformers. Each current transformer supplies one current coil in the

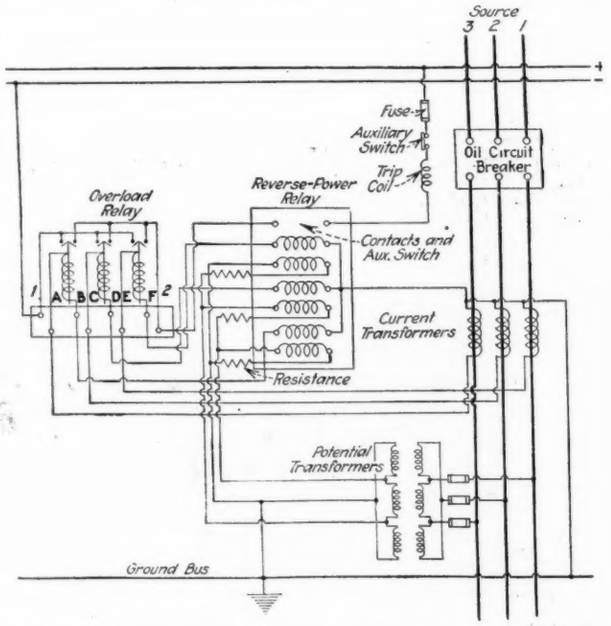


FIG. 10. CONNECTION FOR PROTECTING A THREE-PHASE CIRCUIT WHEN THE RELAY, FIG. 7, IS USED

reverse-power relay and one overload relay. The trip of the reverse-power relay is connected in series with the overload relays and operates the breaker.

There have been a number of other types of relays developed to operate on reverse power, but in most cases they can be regarded only as a modification of "overload" (excess-current) relays, which, with given conditions of superimposed voltages as regards value and direction, will trip at different values of current. They become practically "current" relays when the voltage drops very low.

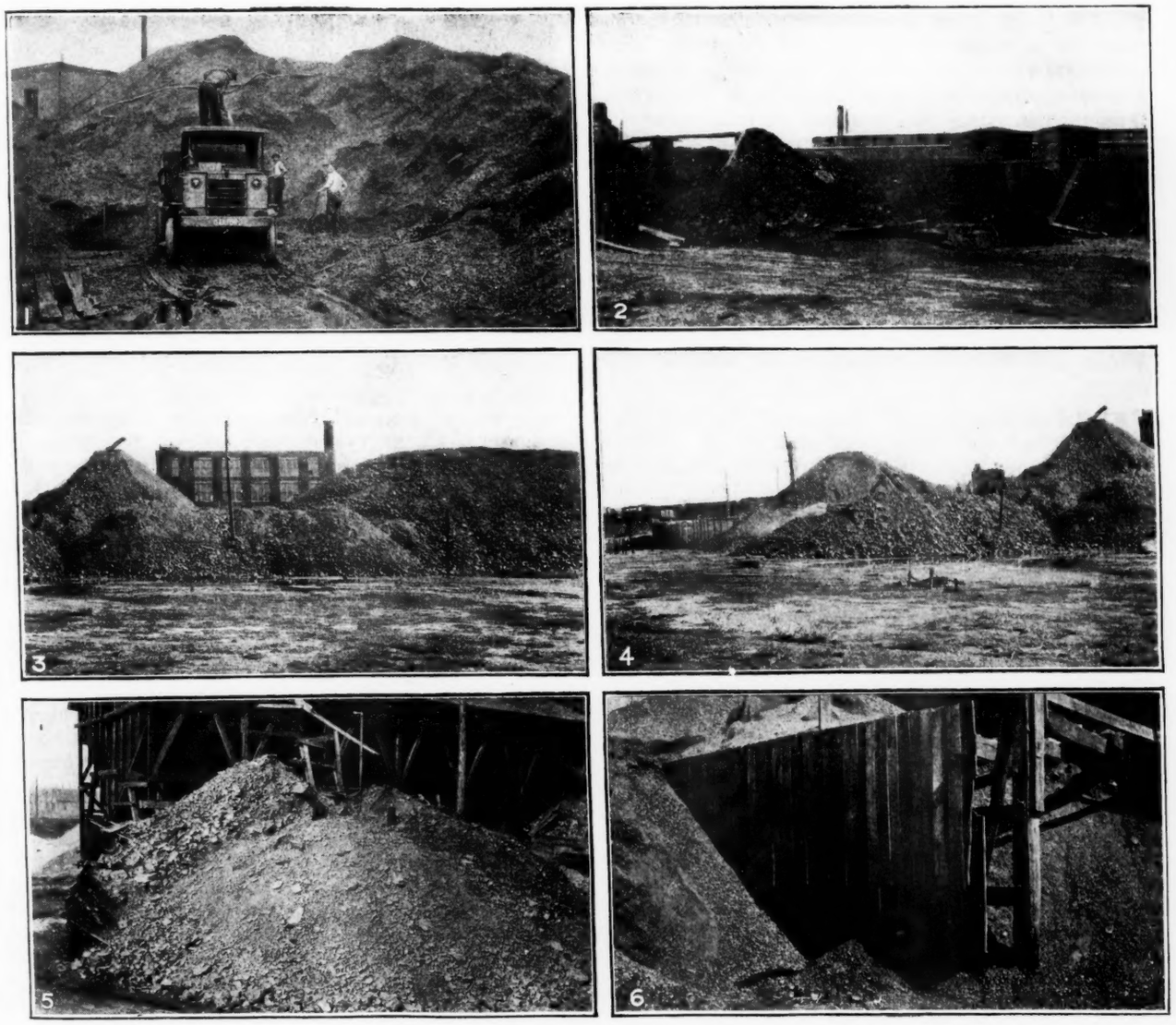
The Storage of Coal

The Relation the Method of Piling Coal Bears to the Number of Fires—Data Collected and Here Presented, Shows That Hand Shoveling Reduced the Fire Hazard

By W. D. LANGTRY
President, Commercial Testing and Engineering Company, Chicago

WHEN placing his storage, it would seem that the average consumer of coal thinks only of how to unload it in the cheapest manner possible. He seldom takes into consideration the expense attached to removing a pile of coal should it catch on fire, or using some other means of quenching it. The one thought is to get it on the ground and then trust to luck that spontaneous combustion will not occur.

Proper piling of coal is probably the greatest factor in reducing spontaneous combustion to a minimum. It may seem to be a little more expensive to pile the coal properly at the start, but the old saying of "an ounce of prevention is worth a pound of cure" applies in this case. The cure at one yard in Chicago was to pick up several thousand tons of coal, haul it a mile to a vacant lot and spread it out to allow it to cool off.



METHODS OF PILING COAL

Fig. 1—Screenings unloaded by clamshell. Fig. 2—Coal unloaded by wheelbarrows. Fig. 3—Coal unloaded by clamshell. Fig. 4—Coal being removed after firing. Fig. 5—Coal unloaded by conveyor and chute. Fig. 6—Coal unloaded from side-dump cars on a trestle.

Some interesting data were gathered, and are now being printed by the Illinois Engineering Experiment Station in Bulletin No. 116, on different methods of unloading coal and the number of fires that started. The accompanying table was taken from this source. It indicates that coal shoveled by hand shows the least percent-

age of fires. The reason for this may be that when the hand method is used, the piles will be small and low. No doubt one of the greatest contributing factors to spontaneous combustion is the segregation of the sizes. No matter what the device is for unloading, it should not have the tendency to separate the fine coal from the large. The finer the coal the more rapid will be the oxidation.

In every one of the accompanying pictures fire started and it could be attributed in each case either to pyramiding of the coal or to the inflammable material around which it was piled. When coal is placed in a conical pile, the finer pieces naturally will be found in the center of the pile, while the larger lumps will be at the outside and toward the bottom. This arrangement gives a free passage of air between the lumps to the finer coal, where spontaneous combustion is most likely to be found. The finer coal obstructs the free passage of the air so that it is not cooled by ventilation, and when the fire once starts, plenty of air comes through the coarser coal to accelerate combustion.

Figs. 3 and 4 give an idea of the height of some of the piles. In the background of the latter view a portable crane and clamshell is at work. In subsequent articles more will be said on proper methods of piling coal.

EFFECT ON SPONTANEOUS COMBUSTION OF METHOD OF PILING COAL

Method	Questionnaire A Total	Questionnaire A Fired	Questionnaire B Total	Questionnaire B Fired
Shoveled by hand	11⅓	5⅓	201	35
Dumped from wagon	1	1	..	..
Wheelbarrow	1	..	4	2
Dumped from truck	..	..	4	..
Wheeled scraper	2	2	..	..
Dropped from car	..	..	9	3
Crane (locomotive)	..	..	13	7
Conveyor	..	..	5	4
Dropped from car on trestle	1	1	..	..
Elevator	..	..	7	3
Bridge	..	..	2	..
Hydraulic	½	½	..	..
In hopper	1	1	..	..
Not stated	..	..	58	21
Clamshell	7½	7½	..	..
Crane	35½	17½	..	..
Dodge storage system	1	1	..	..
Belt conveyor	3	1	..	..
Elevator	1	..	..	..
Bridge	2	2	..	..
Raising track on coal	7	3	..	..
Under water	1	..	..	..
Not stated	2	2	..	..
Totals	78	45	303	75

Two previous articles on coal storage by the same author appeared in the Oct. 5 and Oct. 19 issues of *Power*.

The Oil Situation—The Effect on the Oil-Engine Industry

By E. T. ADAMS

THE production of oil within the United States is now believed to be practically at its maximum. New development may hold our output for a few years at the present figure or even make a small increase, but very soon we must face a constantly diminishing supply of crude oil. At the same time, the production of motor cars, trucks, tractors and oil engines is increasing at a rate never before equaled in our history.

There are those who discount heavily all tales of oil shortage. They point to our reserve of oil-bearing shales; they expect the chemist to make good when the oil prospector fails. But no one denies that demand is now increasing much faster than supply, nor longer ignores the fact that soon there will not be enough oil to go around. This is not a matter of opinion; it is a matter of statistics, available to anyone who has the interest to look them up.

Economy Necessary

Before we abandon ourselves to utter despair it may be well to consider the grounds upon which these predictions are based, and when we do so we at once find a 100 per cent ray of hope. All predictions as to the future of our oil supply are based on three things: The present rate of supply, which we admit to be near its maximum; the present demand, which we admit will increase at a rapid rate; and present methods of use, which are wasteful, extravagant and foolishly short-sighted. By economy we can, in effect, double our present oil supply, and we will speedily practice that economy because rapidly advancing prices of the higher grades of oil and preferential selection in its use will speedily drive us to it.

A statement that half of our oil supply is wasted by the user is a sweeping assertion, difficult to prove, but no one who knows the facts doubts its substantial accuracy. I shall not attempt a proof, but here submit some of the bases for this belief. First, the motor car. In so far as power is concerned, cars are sold on the basis of speed and acceleration. The motor and the carburetor are designed solely on that basis. There is probably no motor salesman who knows the fuel consumption of his motor in terms of fuel per horsepower-hour at any load. It is his business to sell cars, and in order to do so he talks economy and demonstrates speed and acceleration. He boasts openly of speeds double that which are allowed by any law, and he shows you all the acceleration that he can attain. Since it is the demand of the buyer, every car has a motor designed to give speed and acceleration, normally operating with very poor economy because the motor is underloaded and the carburetor is set with a mixture far too rich for economy. Carburetor manufacturers build carburetors to sell to car manufacturers, who, in turn, insist on the speed and the acceleration that you and I demand. When you and I demand economy we will have cars with smaller motors, and carburetors designed for economy. This, even in our present large and therefore wasteful motor, would give an increase of 50 per cent in economy. Such a carburetor would be very different from present types. It would actually put into the cylinder a true vapor or, at worst, a very near approximation to it. Our present-day speed and acceleration carburetors do not by any means put into the cylinder either of these things, as inspection through a glass manifold will speedily show.

The truck and the tractor should use kerosene either in a carburetor which actually vaporizes the oil, or under a boiler, or in a high-compression engine which burns the oil practically with Diesel economy.

We have a merchant marine, designed seemingly by that fond generation who believed that all our natural resources were "boundless" and "inexhaustible," a new but antiquated oil-burning mechant marine which demands three times as much oil per ton-mile as would be required if the oil were burned in modern marine oil engines. When oil was "cheap" and the supply was plentiful, the railroads were cultivated as potential users of large quantities of oil, and today oil-burning locomotives haul freight and passengers parallel to streams that might furnish hydro-electric power, or past mines the waste from which would generate at the mine electric current which would save the oil burned in many locomotives.

Illuminating Gas Demands

Then there is gas oil, a rich oil of about 34 gravity, high in illuminants, supplied to our public utilities; this is a preferential use, ahead of your demand and mine, because the good of the community is of higher importance than the good of the individual. But why do we use gas oil? We use gas oil to enrich gas, to supply illuminants to a gas already high enough in heat value; we furnish gas oil to comply with laws regulating the candlepower of gas sold to communities, and candlepower relates to the illuminating power of gas when burned in an open burner. Very little gas is now burned in an open burner since a mantle-type burner gives far better light and uses much less gas than that consumed by the open burner. Furthermore, electric light has largely supplanted gas light and gas is now chiefly used in stoves. It is a means of heat rather than light, and illuminants have no special value in a heating gas or in a gas burned in a mantle. Our lawmakers are not supposed to know this, but if we could make them know it, it would cost less money to make gas, to the potential benefit of the user. This would at once eliminte another serious waste of oil.

If the reader is not prepared to admit that we use a half and waste a half of our oil supply he must at least admit an astounding waste and therefore be prepared for the changes which wasteful use is bringing about; for it is no longer entirely a matter of price, although the price naturally will be higher. It is a question of preferential use, a question as to who shall have oil and who shall do without. Preferential use of oil has been with us for a long time; it began years ago, when the familiar red 28-gravity "fuel oil" disappeared from the Eastern market. One recalls the consternation and despair with which one received the announcement that "fuel oil" would no longer be supplied, yet today the gas producer has entirely supplanted the fuel-oil tank, and this fuel oil is now converted into a large percentage of gas and a small percentage of heavy residuum.

Future Grades of Fuel

This is the new condition that now confronts us. The majority of the old familiar grades are no longer on the market, but by modern processes are being converted into four products—gasoline, kerosene, a heavy Diesel oil and an extremely heavy residuum which can be burned under a boiler only by the use of special appliances. Of these products two may be further broken down to furnish gasoline and a heavy residuum—kerosene which furnishes a large percentage of gasoline and a small percentage of residuum, and Diesel oil, which is already largely residuum and, when "cracked," furnishes but a small amount of gas. Because of the lamp trade and the stove trade, and because of a system of tankage of unappreciated magnitude, wonderful even in this day of wonders—because of these things, kerosene will be a permanent product, as will be the heavy residual oils. We may therefore safely adjust our lives and our industries to the four oils—gasoline, kerosene, Diesel oil and residuum; these are the oils from which presently we shall be compelled to choose. Of the others—gas oils, distillates, engine oils of 26, 28 and 24 gravity, and the surplus stocks of kerosene—all are passing, and higher prices will come, especially for the lighter oils.

We may expect that the motor car and the truck will react to this condition but slowly; each has its special problems, aside from mere economy in the use of oil. But the tractor manufacturer has no excuse to offer; a tractor must operate long hours at full power, its operating cost is a tax on a nation's bread. The tractor engine should get entirely away from the carburetor; it should use higher compression and give an approach to Diesel economy. Such an engine is as simple to manufacture as a gasoline engine of the carburetor type. Here at least is an economy that is near at hand.

New Engine Design

The most sweeping result of these new oil conditions is the effect to be expected on the engines designed to use the intermediate grades of oil, such as distillate, gas oil and 28-gravity fuel oil. "Semi-Diesel engines" one might call them from the frequency with which the term appears in their literature. All these will change, the smaller engines to kerosene burners and the larger engines to the high-compression type, not necessarily to the full Diesel with air injection, but changed to an engine that will burn any oil that a full Diesel will burn, to an engine which will produce a brake horsepower from one-half pound of Diesel oil and which is simple, solid and easily operated and cared for. This is the small-power type of the immediate future, and nowhere is oil economy more closely associated with the cost of our daily bread, nowhere an economy more important. There are thousands of acres of lands not accessible to gravity water and beyond the reach of electric power, which are dependent on the use of an economical oil-engine operated pump to keep them in intensive cultivation. To these farmers, to the manufacturer, and the multitudinous user of small power this newer type of oil-burning motor is a momentous advance. I do not know by what name motors of this type will be called, but I believe that they will be called Diesel engines. They will lack the panoply which we have come to associate with the name Diesel—there will be no air injection. The type will be simple, dustproof and foolproof; they will burn Diesel oils, on approximately the Diesel cycle, and will give approximately Diesel economy. They will be in truth highly simplified Diesel engines of moderate power.

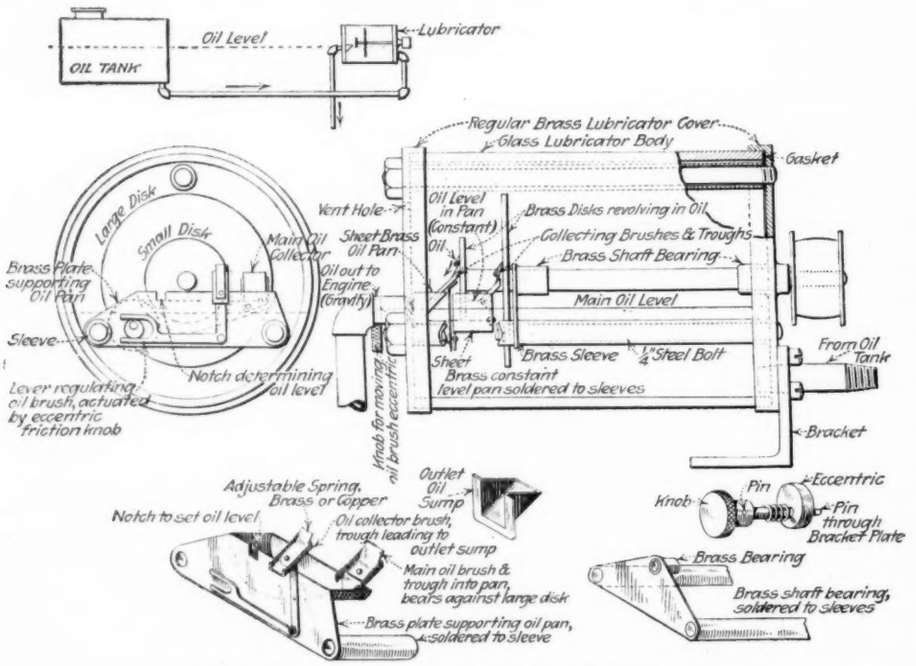
We have reached the peak of our oil production through a period of reckless waste by user and by manufacturer. From now on we will conserve our diminishing stock of natural oils by the use of motors of the most economical type and by refusal to supply oils for unnecessary use. The next generation will approach our untouched shales with appreciation of their value and economy in their use, and they will recall with proper horror the criminal waste and foolish extravagance that characterized the attitute of us, their fathers, toward the oil supply which was our heritage.

Mechanically Driven Gravity-Feed Lubricator

By H. H. Parker

If an engine or machine bearing is to be supplied with oil by gravity feed, it is in some cases an advantage to have the oil fed into the lubricator pipe by positive mechanical means, so that when the machine stops the oil will also stop feeding (the lubricator being driven from the machine itself) without the operator having to shut down and open it up; furthermore, as the machine slows down or speeds up, the oil supply will be correspondingly affected.

The illustration shows a lubricator of this type that can be built from an old glass-body gravity-feed oiler with but little machine work, the construction being chiefly drilling, cutting, bending and soldering sheet brass. It has the advantage that, owing to the glass body, everything is always in plain sight. The lubricator body is turned on its side and a shaft fitted into one end. Usually, the regular brass heads may be used by cutting away the central column and plugging and soldering up openings and cutting new ones where required. Instead of the usual center support for the heads, three small steel through bolts are used with brass spacing sleeves slipped over them to which the various parts are soldered.



GRAVITY-FEED LUBRICATOR MECHANICALLY DRIVEN

As the shaft is under no working strain, it can be of small diameter, and two brass discs are soldered to it, one as large as will swing inside of the sleeves and the other smaller. These discs must run as true as possible on the shaft. The outer shaft bearing is soldered or screwed into one of the lubricator heads, while the other is soldered to a sheet-brass support plate, which in turn is held to two of the sleeves.

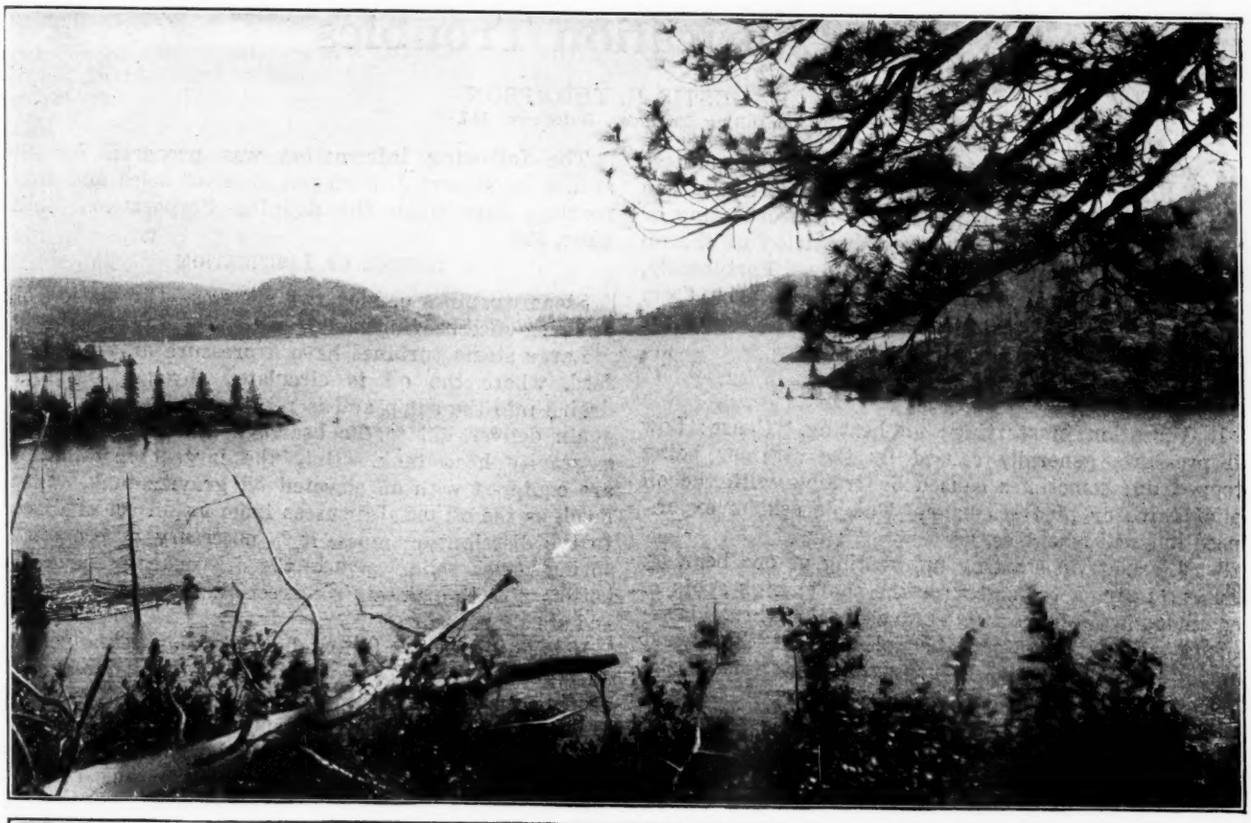
Near one end of the lubricator body, opposite the drive-pulley end, is attached a sheet-brass oil pan into which the small disc will dip; the top of this pan reaches nearly to the shaft, though the depth of oil in it is regulated by a notch cut in the side, should this prove necessary. A sheet-brass triangular-shaped oil sump is riveted and soldered to the inside of the head next to the oil pan; a brass pipe screwed into the head leads into the sump pan and furnishes an outlet for the oil running to the bearings to be lubricated. Another pipe from the oil tank, if one is used, forms the oil inlet. Two spring brass or copper brushes bear against the revolving discs and scrape off the oil; small troughs bent around the collector brushes guide the oil into the pans. The brush bearing against the smaller disc should be the narrower.

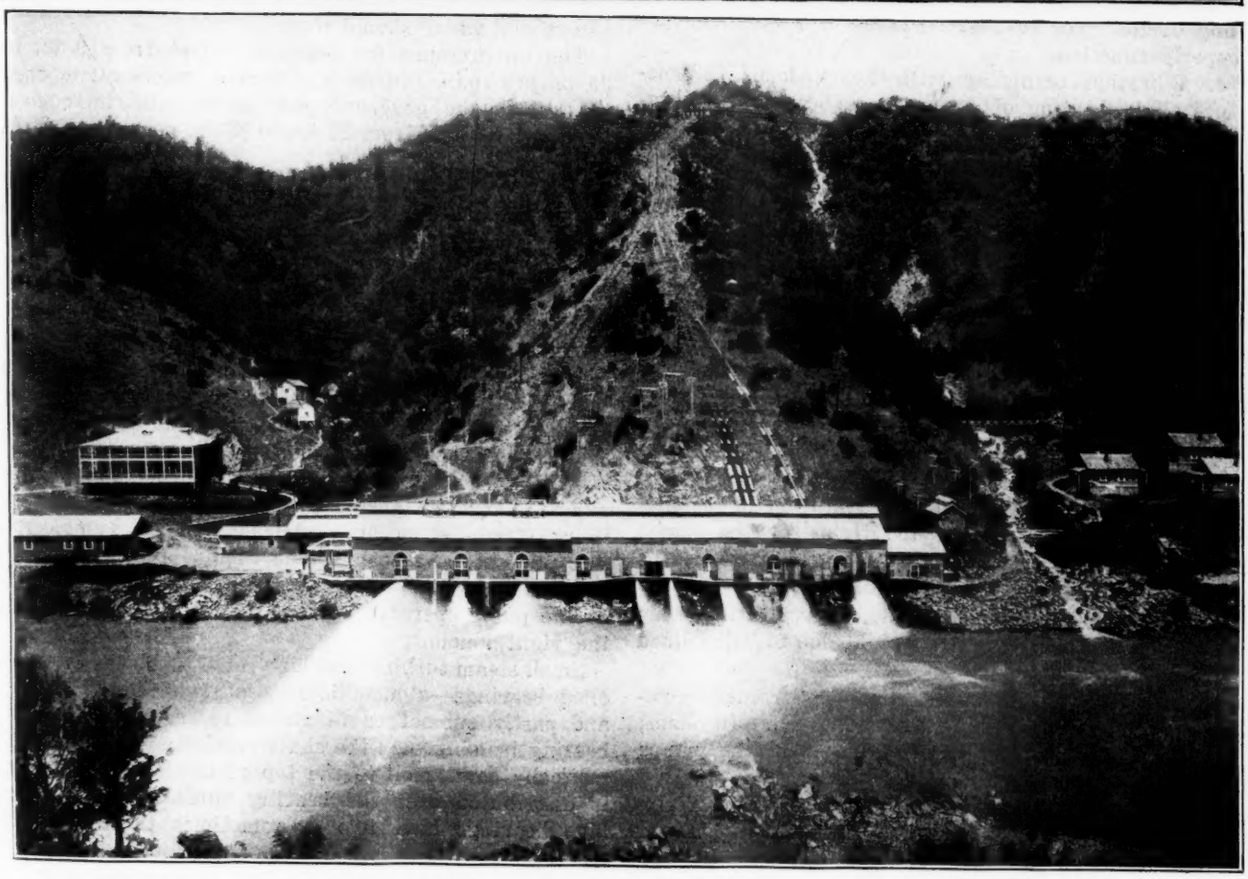
In operation the lower part of the lubricator body is filled with oil, preferably from a large separate tank whose oil level will be the same as the level of that in the lubricator. The large revolving disc carries the oil around until it is scraped off by the collector brush and runs into the constant-level oil pan (the oil level in the lubricator will not stay constant), from which a smaller quantity is taken off the other disc and led into the sump and thence by gravity to the bearings. The amount of oil finally delivered is determined by the level in the pan, the size and speed of the disc, the width of the collector brush and the position of this brush on the face of the disc. This latter may be changed during operation by a sheet-brass bell-crank lever and an eccentric actuated by a milled knob on the lubricator head, which will shift the brush back and forth over the face of the small disc, and thus regulate the amount of oil delivered. The excess which runs into the constant-level pan overflows and joins the main oil supply in the bottom. The speed of the shaft must be slow enough so that the oil will not be thrown from the edges of the discs; this, as well as the proper dimensions of the discs, height of oil level, etc., is best found by trial.

A bracket screwed to one or both heads secures the lubricator to the engine or machine frame, from the shaft of which it is driven by flat or round belt, chain, gears or even a ratchet wheel. No dimensions have been given, as these would depend entirely upon the size of lubricator used and the amount of oil feed desired. The separate oil tank may be placed at a point distant from the lubricator, but at the same level, and piped to it; without the tank the lubricator would require frequent refilling unless but a small amount of oil was required.

Upon taking charge of a new plant, do not begin making promiscuous adjustments. It is better to wait until the equipment is thoroughly understood. Neither does it pay to criticize the departing engineer until you fully understand the plant's condition.

Two Views of the Pacific Gas and Electric Company's Properties, San Francisco, Cal.





TOP: LAKE SPALDING; A 275-FT. DAM CLOSES A NARROW GAP AT FAR END OF THE LAKE USED FOR WATER STORAGE. BOTTOM: COLGATE POWER HOUSE ON YUBA RIVER, 20,000 HP. CAPACITY

Operation and Adjustment of Turbine Machinery
X—Lubrication Troubles

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Md.

OIL troubles may be classified under two headings: First, those caused by the mechanical condition of the machine which results in overheating or vibration; second, those due to composition of the oil itself and its behavior in the machine. Fortunately, mechanical troubles, while few in number, arise from a variety of causes and are diagnosed by different characteristics.

Mechanical Oil Troubles

1. Vibration in starting; no heating. Cause: Low oil pressure, generally caused by the strainer being stopped up; sometimes caused by trouble with the oil relief valve or pipe stoppage. This is seldom experienced in small machines.

2. Vibration in starting up, heating at one bearing. Causes: Bearing too small for the shaft; high spots in the liner; lack of proper clearance in the thrust bearing; misplaced shim or other element of the thrust bearing; rubbing between moving and stationary elements at point of heating.

3. Vibration appearing suddenly with hot bearing while machine is in normal operation. This is caused by failure of the oil supply, such as a break in the pump, stoppage in the oil system, and improper assembling of the liner so that oil holes or grooves do not properly function.

4. Vibration occurring with heavy loads. Sometimes slight heating of one or more bearings. Vibration disappears when load is removed. This is caused by bad alignment of the bearing pillow blocks or bearings bored out of true.

5. Vibration occurring when machine has reached a good hot running temperature and especially in changing over from condensing to non-condensing. Sometimes slight heating in one bearing. Cause: Self-aligning bearing having too tight a fit, so that it does not change its position when expansion changes the position of the shaft.

6. Continual vibration noticed in one bearing, principally with a slight pounding noise. This may be due to a self-aligning bearing fitted too closely in its ball seat.

7. Heating of bearing without vibration in starting or running. Causes: Liner too tight for the shaft; high spots in the bearing; thrust-bearing troubles as mentioned in No. 2; failure of the oil supply.

8. Slight heating of one bearing. No vibration. This is caused sometimes by extra weight due to being lined too high.

9. Failure of the oil supply. Causes: Strainer becoming stopped; water finding its way into the oil system; stoppage in piping; excessive clearance in the pump; bad oil leak in the system; lack of oil.

10. Oil leaks. Causes: Pipe joints; vibration of piping; strains in piping due to improper support or alignment; porous metal.

11. Oil throwing. Caused in general by air currents carrying minute particles of oil from the bearings or from leakage oil.

The following information was prepared for the author by Robert J. Stringer, chief of sales and engineering, Pittsburgh Oil Refining Corporation, Baltimore, Md.

System of Lubrication

Steam turbines employ two systems—Circulation oil, and ring-oiled bearings.

Large steam turbines have a pressure or gravity oil feed, where the oil is circulated through bearings, drains into the sump and is returned by a pump which again delivers oil to the bearings directly or through a gravity head tank. Only the largest installations are equipped with an elevated oil gravity tank. Inasmuch as the oil usually passes from an oil cooler direct to the distributing pipes, it is necessary to provide a spring-loaded relief valve in the delivery pipe near the bottom pipe to maintain a correct oil supply at a proper and steady pressure.

It is good practice to install sight feeds in the return oil pipes by means of which the flow of oil from each bearing may be observed. Test cocks are often fitted to the top of the bearing housing, which, if opened, show the flow of oil reaching the bearings. Both the elevated oil gravity tank and the bottom tank (sump) are equipped with drain cocks to permit draining off sludge and water should these collect.

The oil pressure for bearings varies from 3 lb. to 35 lb. per sq.in. In cases, however, where oil is used to operate the governor gear it may be introduced under a pressure from 25 lb. to 80 lb. per square inch.

Two Oil Pumps Are Sometimes Used

Two pumps are occasionally used in the oil-circulation system—one for bearing lubrication and one for supplying oil under high pressure to the governor. In a direct-pressure feed system one pump only is used, and this pump must deliver all the oil at a pressure sufficiently high to work the governor.

When starting up turbines not equipped with overhead tanks, the oil supplied to the bearings is not sufficient until the turbine is running at about 25 per cent normal speed. Therefore it is necessary when starting up a small turbine, to feed the bearings by hand pump. Large turbines are supplied by means of auxiliary steam-driven or electrically driven pumps for this purpose. As soon as the turbine reaches normal speed the auxiliary oil supply should be discontinued, as the pump operated by the turbine will now supply the right amount.

Small steam turbines are lubricated by means of ring-oiled bearings—a metallic ring suspended on a shaft and partly submerged in an oil reservoir within the bearing housing. As the shaft revolves, the ring automatically carries oil to the top of the shaft, where it is distributed over the bearing surface. Many turbine bearings have two or sometimes three metallic rings.

Water, unfortunately, does find its way occasionally into the oil system through steam leakage of the gland packings and from water leakage of the oil-cooling

apparatus. If a large quantity of water works into the oiling system, it is usually due to leakage of water from the cooling apparatus. A large accumulation of water is harmful, and steps should be taken immediately to drain off the water. If the conditions of leakage cannot be corrected, a water trap should be installed in the bottom tank or sump. Excessive water circulating with the oil will, by this means, enter the trap, from which it can be easily drained off.

Water in a circulating system is objectionable. It is therefore considered good practice to remove a certain quantity of oil from the bottom tank each day. Three to six gallons should be withdrawn daily in large turbine installations and put through a steam separator and filtered. An amount of oil should be added equal to the quantity withdrawn, plus any necessary "makeup" oil required.

Large oil-circulation systems are an important factor in correct lubrication as they afford time for the impurities to settle from the oil. If only a small quantity of oil is in the oil system, circulation is too fast and the impurities have not time to separate readily from the oil.

A dual, or double, oiling system is ideal. By such a system the life of the oil is maintained almost indefinitely.

Broken-Down Oil

Broken-down oil is the result of the steady circulation plus the action of heat, air and moisture. An analysis of broken-down oil will generally reveal an increase in viscosity and gravity, sludgy deposits and strong acidity.

The life of an oil is dependent upon its quality and suitability. Incorrect oils will not stand up for any considerable time, and their breakdown is sure, quick and complete. A drawn-off sample of broken-down oil shows that it contains three distinct substances. The top section represents clear oil, the next layer is a slimy mixture composed of sludge, and the bottom is discolored water. Broken-down oil in the middle of the three sections may be due to inferior oil or to an electrical or mechanical action upon the oil.

Broken-down oil always accumulates in the most dangerous places—the oil pipes which lead the oil from the distributing pipes to the bearings. This sludge accumulation frequently results in a partial blocking of the pipes, sometimes retarding the flow of the oil. Broken-down oil also clings to the coils in the oil-cooling apparatus, thereby lowering the cooler efficiency, resulting in a rise in the temperature of the oil, which in time will unduly shorten the life of the oil.

The amount of makeup oil to be added to a system on account of leakage and evaporation varies with the type, size and speed of the turbine, and the capacity of the oil system.

Starting a New Turbine

When starting a new turbine the oil should be strained before it is put into the system and care should be taken to allow no dirt or other impurities to enter. The original charge of oil should be removed after a run of two or three weeks, to allow any dirt, sand, waste, packing, etc., which do at times get into a new circulating system, to settle. If the original charge of oil, when removed for settling, is badly contaminated it should be heated and then put through a good filter.

The oil temperatures in circulation systems rise gradually until they become constant. In large turbines the constant is reached in approximately twenty-four hours' continuous work and in small turbines in four hours' continuous running.

If the oil cooler is correctly designed it will absorb most of the heat in the oil. The governing factors on the temperatures of the oil are the temperature of the cooling water and the size and capacity of the coils in the oil cooler. Generally, the larger the coil surface the lower the temperature of the oil.

To avoid danger of leakage of water into oil, the oil should pass through the cooling apparatus at a pressure greater than that of cooling water.

The temperature of the oil as it leaves the bearings should not be over 130 to 175 deg. F. Thermometers should be installed in all return oil pipes, and if the temperature on any main bearing exceeds 175 deg. F. immediate steps should be taken to ascertain the cause. Most efficient operating temperatures should be about 130 to 140 deg. F.

The following temperature readings should be taken and recorded hourly in the engineer's log book: (1) Temperature of oil as it leaves each main bearing; (2) temperature of oil before it enters the cooler; (3) temperature of the oil after it leaves the cooler; (4) temperature of cooling water before it enters the oil cooler; (5) temperature of the cooling water after it leaves the oil cooler.

Oil Vapors and Deposits

Oil vapors occasionally are drawn from the bearings and oil tanks into the electric generators, even under normal temperatures. These vapors are caused by the rapid circulation of the oil, in conjunction with air-producing small "oil-air" bubbles. These bubbles, when bursting, produce the oil vapors. If the return pipes are not large enough to carry off the oil, it foams and produces more vapors. A vent pipe may, in some instances, be fitted into the oil reservoir to carry off this excessive vapor and foam. It is of vital importance that the oil pipes be kept free from air as far as it is practically possible.

Deposits are the results of the following effects or causes: (1) Water; (2) air and heat; (3) solid impurities; (4) electric action; (5) adding excessive amount of new oil to old oil.

Water: Large quantities of water, when in violent agitation with oil in circulation, will form an emulsion. If a great quantity of water leaks into the oil system the mixture becomes brownish yellow in color. If a sample is heated and allowed to settle, it will evaporate into three distinct substances (see paragraph on broken-down oil). The layer of oil in such cases will be darker than when originally placed in the oil system and will tend toward manifesting a strong odor. Its viscosity will be higher and it will contain a small percentage of mineral acid, due to the breaking down of the oil from oxidization. The mineral acids do not affect materially the metals used in turbines, but they will in time slightly dissolve zinc or alloys composed largely of zinc. The sludge produced by the water will clog the oil strainers, oil pipes to the bearings and the oil inlet to the governor.

Air and Heat: Air in small quantities is always present in a circulating system, and if the oil temperature is above normal the air tends to oxidize the oil. If oxidation takes place the oil becomes much

darker and a black carbon deposit will choke up the oil pipes to the bearings and may stop the governor gear.

Solid Impurities: Solid impurities such as iron oxides, dirt and dust, when oxidized by the high temperature of the oil in circulation, will darken the color of the oil, increase the viscosity, produce mineral acids and broken-down oil. The oil will smell burnt and will deposit a slime on the cooler coils. Oil tanks should be kept clean, free from dirt and rust and never painted with non-oilproof paints, as the oil will in time decompose the paint and oxidation will result.

Electric Action: Electric currents sometimes leak along the bearings from both alternating- and direct-current generators and act injuriously on the oil. The effects of electrical action are an increase in the intensity of dark color of the oil, high percentage of acidity, and a deposit which sticks to all parts of the lubricating system, particularly the oil cooler. The deposit is dark, hard, brittle and difficult to remove. It is good practice to insulate one of the generator main bearings from the turbine bedplate, thereby preventing the passage of electric currents and the resultant deposits.

Adding New Oil: If little or no water is finding its way into the circulating system, and if the leakage of oil is so small that little or no oil is added every week, the oil will in time turn very dark and become quite acid. In such cases, particularly if ordinary non-homogeneous oils are in use, the action of new oil on the old produces a dark deposit.

Correct lubrication means the *right* oil, the *right* flow, applied in the *right* way at the *right* time. By this means turbine oil will operate at least 12,000 working hours, and in an oil-circulation system and under abnormally hard operating conditions for 3,000 working hours. Turbine oil, when used in ring-oiled bearings, should be drained from the housing and recharged with new oil every six months.

Hints for the Engineer

High-grade turbine oils, refined from selected crudes, are the correct lubricants for turbine lubrication because they are more immune from heat, water, air and impurities than asphaltum-base oils; furthermore, they will separate quickly from all impurities, absorb the heat in the bearings and thereby keep operating temperature of bearings normal.

When starting a new turbine, oil should always be strained before placing it into a lubrication system. Remove and strain the oil after not more than three weeks' operation and replace it where it is not practicable to install a new charge.

The amount of makeup oil to be added depends on the size and capacity of the system as well as the quality and suitability of the oil in use. If the system is free from leaks, the amount of makeup needed will be small. It is good practice to add a little oil every day rather than a large quantity once a week.

The writer has not here attempted descriptions of the oil filtration systems so largely used with steam turbines.

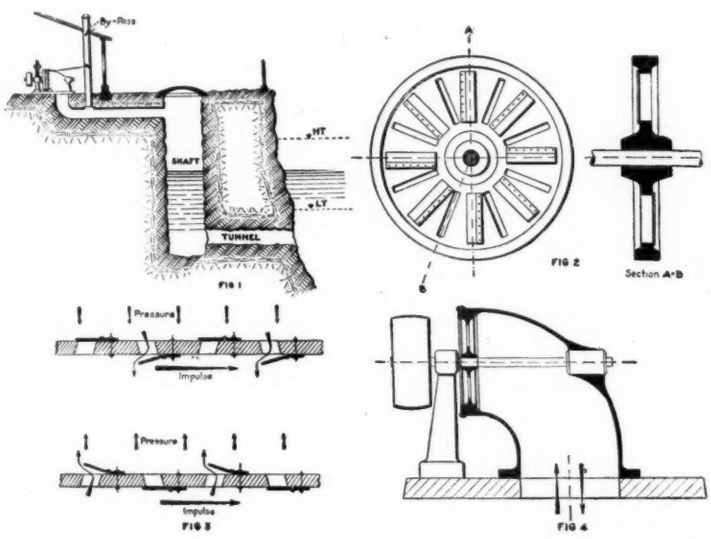
Babbitt metal should not be reused since every time the babbitt is melted some of the tin and antimony are burned out.

Wave-Motion Turbine

By Arthur Palme

The practically never-ceasing wave motions of oceans are responsible for the legion of mechanical devices intended for their utilization. As far as known to the writer, most of these contrivances are based on the same principle, namely, a body of wood or hollow-metal floats upon the surface of the water, is made, therefore, to go up and down with the waves, and by some device the reciprocating motion is either used directly to pump water or to compress air, or is transformed into rotatory motion by ratchets, etc. All these constructions have inherently four main faults, which either make their function not satisfactory at all or permit of only a short usage.

The first disadvantage is caused by the fact that next to wave motion every ocean has a more or less pronounced tide. It is therefore necessary to so arrange



FIGS. 1 TO 4. ASSEMBLY AND PARTS OF WAVE-MOTION TURBINE

and regulate the floats that their proper action is not interfered with by the tides. If this has to be done by hand, constant supervision is required.

The destructive chemical action of sea water to all metal that comes in direct touch with it and all machinery that is exposed to sea atmosphere constitutes the second disadvantage.

Seaweed floating on or near the surface of the water interferes frequently with any mechanical apparatus that may be floating in the water and represents the third disadvantage.

The fourth, and probably the greatest enemy of all known "wave-machines," are storms, with their almost unlimited energy.

Ten years ago I was delegated to investigate the possibilities of a new wave-motion turbine, the principle of which is so radically different from all previous designs that a short account of the device will be of interest. The inventor, is Bouchaux-Praceique, of Royan, France, near Bordeaux. All the light and power used in his house was generated with this wave-motion machine. It is not the purpose of this article to reflect upon the possibilities of this scheme on a larger scale. The fact is that a turbine of this kind, coupled to a

one-kilowatt direct-current generator ran during practically all the time I was investigating the plant (one week). Short periods of rest were easily taken care of by a small storage battery.

A rocky part of the sea shore is essential for the location of this scheme (see Fig. 1). The lowest level of the tide *LT*, is determined, and some 10 ft. below this level a horizontal tunnel is driven. At a suitable distance inshore a vertical shaft is sunk to meet this tunnel. It is obvious that the water within the shaft, communicating with the sea, will duplicate all motions of the sea-water level, so that the waves will cause an alternate rising and falling of the water level within the shaft.

The top of the shaft is closed up by masonry work or a dome of cement, and a pressure pipe is carried from the top of the shaft to the turbine location. This pipe should be located high enough above the high-tide, *HT*, level to prevent water ever entering it. The turbine is a low-pressure unit of special design, the runner of which may be horizontal or vertical. The runner consists of a disc flywheel, Fig. 2, with a number of obliquely arranged radial openings. All the even openings are closed upon one side and all the odd openings on the other side of the wheel. Closing these openings are long, narrow strips somewhat wider than the former, made so that they will open along a radius of the wheel as axis-like vents. Metal-lined leather, held down with springs, has been used by the inventor.

By referring to Fig. 3 it will be seen that if there is a positive pressure applied against the wheel, the inner vents will all be closed and all the outer vents will open to permit the escape of the pressure. A reaction will take place, giving the wheel an impulse in the direction indicated. If negative pressure is applied, the outer vents will close, the inner vents will open with a resulting reaction impulse in the same direction as before.

In case of a wheel on a horizontal shaft this runner is mounted at the mouth of a 90-deg. tube, as shown in Fig. 4. Sufficient rim weight is used on the wheel to obtain the necessary flywheel effect to overcome the periods of diminishing pressure, reversal and starting suction.

Means of Regulating Voltage

Regulation of generator voltage may be obtained, either by employing a type as used on Pullman cars, where the voltage is practically constant within a considerable range of speed, or else mechanically. The machine in question had a small centrifugal governor operating an air bypass in the connection between the surge well and the turbine. While this special turbine will no doubt have a very low mechanical efficiency, it might be possible to develop along similar lines a type of better characteristics. The inventor had a storage battery floating on the mains all the time, to tide the set over occasional idleness.

This idea represents a decidedly novel way to utilize the energy of sea-wave motion. It is independent and unaffected by tides. No wooden or metallic parts are exposed to sea water and liable to corrode. Seaweeds floating on the surface of the water cannot affect any mechanical part or clog the tunnel. Storm and surf of the most violent nature find nothing but nature's rocks to beat against. As a matter of fact, the more violent the waves the more power may be obtained from the turbine.

Thor Moisture Separator for Air Lines

The Independent Pneumatic Tool Co., 600 West Jackson Blvd., Chicago, builds the Thor moisture separator shown in the illustration for separating and cleaning the moisture and dirt out of compressed air. It fills a want that is appreciated by every user of pneumatic tools who has experienced difficulty due to water and dirt causing the pistons and valves to stick.

THOR AIR-MOISTURE SEPARATOR

The air enters the separator through two separate pipes and strikes the inside wall or casing of the separator tangentially, causing the air to revolve rapidly, and the centrifugal force throws the moisture and dirt to the walls, from which they drain off and fall to the bottom, while the cleaned air passes on to the pipe line. A drain at the base of the separator is provided for removing the accumulations of water and dirt. The separator is built in two sizes of 150 and 400 cu.ft. capacity per minute. It is equipped with a pressure gage having a face 3 in. in diameter. The height of the separator is, including the gage, 31 and 47 in. respectively. The diameter of the base is 8½ and 12½ in. according to the size of the machine.

Suspension of the service order giving priority to coal for Lake shipment seems imminent. The saturation point appears to have been reached in the Northwest. There is great congestion of coal in lower Lake ports, with little market in evidence in the Northwest. A potent factor in the situation was the transfer by the Northwestern railroads of 3,000,000 tons of coal from the Lake territory to Illinois. Apparently, considerable numbers of industrial orders have been placed in Illinois at better prices than could be obtained at the lower Lake pools. The National Committee on Gas and Electric Service is being flooded with requests from public utilities for relief. Most of the requests, however, are for assigned cars. George W. Elliott, the secretary of the National Committee on Gas and Electric Service, is advising all public utilities that an emergency must be clearly established before any type of relief is extended and assigned cars are to be granted only when all other means of securing coal for the utility have failed. Mr. Elliott points out that the Interstate Commerce Commission feel that it is incumbent on the public utilities to secure their coal supply by regular commercial methods.

Throwing water on burning oil merely spreads the flames. Sawdust or sand, if liberally sprinkled over the oil, will subdue the flames.

Refrigeration Study Course—XVI
Ammonia Pipe Calculations

By H. J. MACINTIRE
Professor of Refrigeration, University of Illinois, Urbana, Ill.

ALL steam engineers understand the importance of proper pipe sizes and connections. With steam it is necessary to prevent excessive pressure drop as well as to keep the headers and pipes drained and free from the possibility of water hammer. The pressure drop from the boiler to the engine or turbine results in some loss of efficiency and power. On the condenser side it means the same thing to a much greater degree.

In refrigeration the same general conditions are true, especially as applied to the suction line. The ideal condition is to have the same cylinder suction pressure (the actual pressure during the suction stroke) as the pressure of evaporation in the refrigerating (expansion) coils. This condition is an impossibility because there must be a pressure drop to make the gas flow along the pipe, just as water will flow only when there is a head to cause the flow. This drop

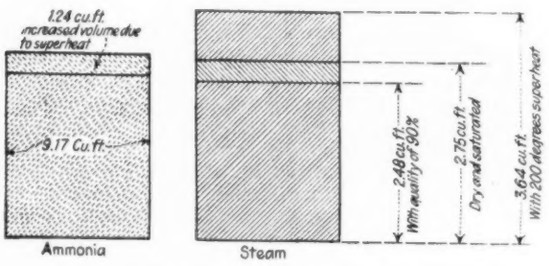

1.24 cu.ft. increased volume due to superheat
9.17 Cu.ft.
Ammonia
Steam
2.48 cu.ft. With quality of 90%
2.75 cu.ft. Dry and saturated
3.64 cu.ft. With 200 degrees superheat

FIG. 1. SHOWING EFFECT OF QUALITY ON VOLUME OF A GAS

of pressure is increased when the connection between the compressor and the expansion coils is increased, when the pipe is decreased in diameter or when fittings, valves, ports and passages offer resistances and cause whirlpool and eddy currents in the gas as it passes along the pipe or passage.

The bad effect of excess head pressure, due to resistances to flow of the compressed gas into the condensers, and of wiredrawing of the suction gas have already been given considerable attention in this study course. The first is reacted directly in the power required to drive the compressor, but the second causes a loss of capacity of the compressor and an increase in the power required. Pressure drop in the suction line is a serious matter and cannot be tolerated. Where the pipe connections in the suction line are short, this loss is not serious as a rule, but frequently, in packing-house, cold-storage and other plants, the return gas has a long way to travel and the velocity must be kept low to prevent excessive losses. But before going into the design of ammonia lines, a few other considerations will be in order.

Fig. 1 shows the effect of the quality on the specific volume; that is, the volume of one pound of the substance. For example, the volume of one pound of ammonia at zero degrees F. boiling temperature is 9.17 cu.ft. for dry and saturated ammonia and 10.41 cu.ft. for superheated ammonia with 50 deg. F. superheat. Therefore there will be an increase of 13½ per cent in volume by being careless in the use of the expansion valve and thereby permitting the gas to return to the compressor headers in a very hot condition. Usually, we try to bring the frost back to the headers, because this gives an outward sign of the condition on the inside of the pipe. But if the volume of the gas may be reduced by eliminating superheat in the suction headers, why not go a step farther and decrease the volume a little more?

Wet compression, the result of bringing wet ammonia into the compressor, has few advocates at present. The same liquid ammonia is believed to give much better results by being allowed to perform its proper function of providing refrigeration in the cooling coils. It seems a roundabout method of cooling the gas on the compression stroke by spraying liquid into the cylinder. Of course the temperature of the gas discharging from the cylinder is reduced, but at the expense of liquid suitable for cooling effect in the expansion coils. The important thing for us all is, What do we get in useful refrigeration per horsepower or per kilowatt input? Most American engineers believe that we get the most economical operation with gas returned to the suction headers in a dry and saturated condition. The use of liquid injection to the cylinders also does not lend itself to easy control without constant care. This brings to mind certain troubles encountered in the expansion coils.

Expansion Coils May Feed at Top or Bottom

The expansion coils may be designed for feeding at the top or at the bottom. With the expansion valve at the top it is believed that there is less danger from slugs of liquid returning to the compressor. The reason for this is that, as the liquid cannot collect appreciably in the coils, the feed cannot well be of the wrong amount without this being noticeable by lack of frost or by too much frost.[1] About the only chance for slugs of liquid is where the pipe allows pockets from which the liquid might be picked up by the return gas. And yet, judging from steam-engine practice, such slugs of liquid are usual only when a great sudden demand for gas or steam due to a change of load causes an appreciable increase in the vapor velocity.

On the other hand, the liquid feed at the bottom of the coils allows them to be operated flooded with better heat transference. Being flooded, the coils may fill completely with liquid (as is frequent if the suction pressure is not low enough for the temperature carried in the surrounding medium) and "lost" or "dead" ammonia results. In addition the liquid is likely to slop over and cause liquid hammer or worse in the compressor. In consequence it is wise to use a large

[1]The presence of frost on the suction bends means that a cold gas is being returned to the machine, with a temperature of 25 deg. F., or lower. Lack of frost means that the ammonia has too great a temperature to hold frost on the pipe or to freeze moisture on the pipe.

liquid separator in the suction line when feeding at the bottom.

In the refrigerating system we have the following pipe calculations:

First, the connections from the compressor to the condenser to convey the superheated gas at a pressure corresponding to the condenser. This may vary from 100 to 215 lb. gage, depending on the temperature and the amount of water used on the condenser.

Second, the liquid line connecting the liquid receiver with the expansion valves.

Third, the suction return from the expansion coils to the compressor lines.

Fourth, the amount of linear feet of piping to be used in the ammonia expansion system.

The Suction and the Discharge Line

The discharge line should be given careful attention. It is true that the amount of pressure indicated by the pressure gage on the condenser is determined by the condenser itself and the amount and temperature of the water showered over the condenser. In other words, the condenser pressure is dependent on the so-called vapor tension of the condensed (liquid) ammonia, but this is not the pressure against which the compressor is pumping. The reason for this is because the compressed gas is made to pass through the ports and valves of the compressor head, then through the discharge bends, past many valves and fittings and perhaps through a long pipe connection (frequently from the basement to the roof) before reaching the condenser and the cooling water. The compressor has the same practical condition as exists in the case of a water pump which discharges into a tank situated at some elevated position. The pump has to work against the static head plus the resistances, which vary directly as the length and inversely as the inner diameter and increased by the kind and number of fittings used. Likewise, the steam engineer who desires a pressure of 175 lb. at the throttle notes that whereas the boiler pressure may be only slightly more than 175 lb. at light loads, yet frequently at full loads or overloads the boiler pressure has to be considerable in excess of 175 pounds.

In like manner the suction pressure is maintained at a certain amount in the refrigerating coils. This pressure has to be a certain amount if refrigeration is to be obtained at a particular temperature. These temperatures are prescribed for each case by the kind of refrigerating work being performed and may vary from 40 deg. F. to minus 10 deg. F. or lower, whereas the boiling temperature of the ammonia has to be 10 or 15 deg. lower still. This suction pressure is maintained by means of the compressor, which "pumps" from the expansion line per minute as great a weight of ammonia as is evaporated every minute. The effective piston displacement is equal to the weight of ammonia evaporated times the volume of one pound of ammonia at the suction pressure.

But naturally, the pressure in the inside of the compressor must be less than that in the suction bends, and these have to be less than the pressure in the expansion coils, for otherwise the gas would not flow in the proper direction. The case is somewhat similar to the condition of a flowing brook. If the water flows, then there is a difference of level. It requires some difference in level (or pressure) to maintain a flow of any fluid against the skin or other resistances of the pipe, duct or channel. Therefore in the case of the suction line there will be a drop of pressure to get the gas into the compressor.

The whole matter of pressure drop may be clarified on referring to the diagram, Fig. 2. This diagram is worked out for a straight length of pipe of 100 ft. Pressure drop increases with the density of the substance and as the square of the velocity. To get this diagram on the paper to best advantage, the author has made the lower diagram for a uniform density corresponding to 20 lb. gage and with different gas velocities up to 6,000 ft. per min. For any other density it is necessary only to project upward until the proper gas pressure is obtained. For example, a 4-in. pipe with

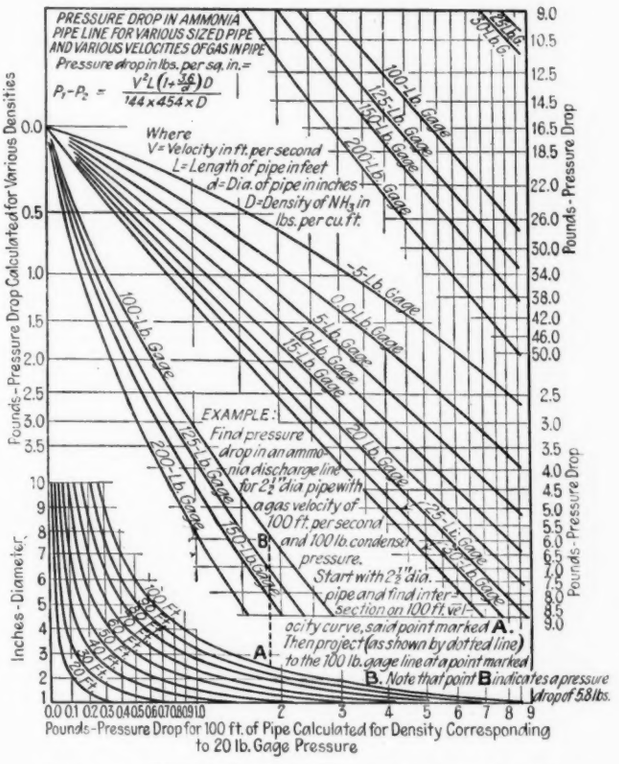

PRESSURE DROP IN AMMONIA PIPE LINE FOR VARIOUS SIZED PIPE AND VARIOUS VELOCITIES OF GAS IN PIPE
Pressure drop in lbs. per sq. in. =
$P_1 - P_2 = \frac{V^2 L\left(1+\frac{56}{d}\right)D}{144 \times 454 \times D}$
Where
V = Velocity in ft. per second
L = Length of pipe in feet
d = Dia. of pipe in inches
D = Density of NH_3 in lbs. per cu. ft.
250 Lb. Gage
200 Lb. Gage
150 Lb. Gage
125 Lb. Gage
100 Lb. Gage
50 Lb. Gage
20 Lb. Gage
15 Lb. Gage
10 Lb. Gage
5 Lb. Gage
0.0 Lb. Gage
EXAMPLE: Find pressure drop in an ammonia discharge line for 2½" dia. pipe with a gas velocity of 100 ft. per second and 100 lb. condenser pressure. Start with 2½" dia. pipe and find intersection on 100 ft. velocity curve, said point marked A. Then project (as shown by dotted line) to the 100 lb. gage line at a point marked B. Note that point B indicates a pressure drop of 5.8 lbs.
Pounds-Pressure Drop Calculated for Various Densities
Inches-Diameter
Pounds-Pressure Drop
Pounds-Pressure Drop for 100 ft. of Pipe Calculated for Density Corresponding to 20 lb. Gage Pressure

FIG. 2. SHOWING PRESSURE DROP IN AMMONIA GAS LINES

gas at 60 ft. per sec. would have a pressure drop of 0.33 lb. per sq.in. per 100 ft. of straight length for 20 lb. density, but this will be 1.9 for 200 lb., 1.47 for 150 lb., 1.03 for 100 lb. and only 0.15 for zero lb. gage pressure. Valves and fittings increase the resistance greatly, which vary from 100 times the diameter of the pipe for a 90-deg. ell to 200 times the diameter for a globe valve. Irregularities of the interior, which will cause whirlpool or eddy currents, increase the pressure drop. The result is that the engineer has to calculate the total effective length of pipe, allowing for each ell, tee, coupling, valve or other fitting, and find the approximate pressure drop from the diagram. Then, by using a liberal factor of safety, the practical working value may be closely approximated.

The question may arise as to how the velocity of the gas may be found. This is determined by dividing the total volume of the gas passing through the pipe per minute by the cross-sectional area of the pipe. The volume is found from the ammonia tables. For example a 50-ton machine pumps against 175 lb. gage and

with a temperature of discharge of 200 deg. F. and a suction pressure of 15 lb. gage. The specific volume at 175 lb. and 200 deg. F. is 2.03 cu.ft., and at 15 lb. gage is 9.17 for dry saturated vapor. At 15 lb. gage boiling pressure of ammonia, there will be required $\frac{200}{L_{15} + q_{15} - q}$ pounds of liquid ammonia per ton, or $\frac{200}{572.1 - 33.5 - 6.86} = 0.426$ pounds.

In other words, there would be required 0.426 lb. of ammonia per ton of refrigeration per minute. For 50 tons there would be 50 times 0.426 times 9.17 equals 195 cu.ft. of suction, and 50 times 0.426 times 2.03 equals 43.3 cu.ft. discharge gas per minute. In a practical problem it is unwise to figure too closely, and therefore the warmest condensing water should be used in calculating the condenser pressure, as well as the lowest suction pressure which experience has shown is likely to be used in getting the work out. Dividing the volume in cubic feet by the area in square feet will give the required answer in feet, velocity of the gas.

In the foregoing an attempt has been made to show the factors influencing the design of discharge and suction lines. Whereas, the first cost of the installation must be kept down to the practical minimum, yet the daily operation must not be handicapped by faulty designs. A refrigerating plant, like any system with continuity, must be balanced in all its parts.

Air for Burning a Pound of Coal

By C. C. Phelps

Pounds of water evaporated per pound of fuel, or per pound of combustible, is the telltale of a boiler plant's efficiency. This ratio, in turn, depends primarily upon another ratio—that of pounds of air supplied to burn each pound of fuel. If the air-fuel ratio is large, the evaporation will be low, and conversely, if the air-fuel ratio is small the evaporation will be high unless some other factors interfere to prevent the latter result. It should always be the aim to burn fuel with the minimum

WEIGHT OF AIR PER POUND OF CARBON IN THE COMBUSTIBLE AS INDICATED BY CO_2 IN THE FLUE GAS

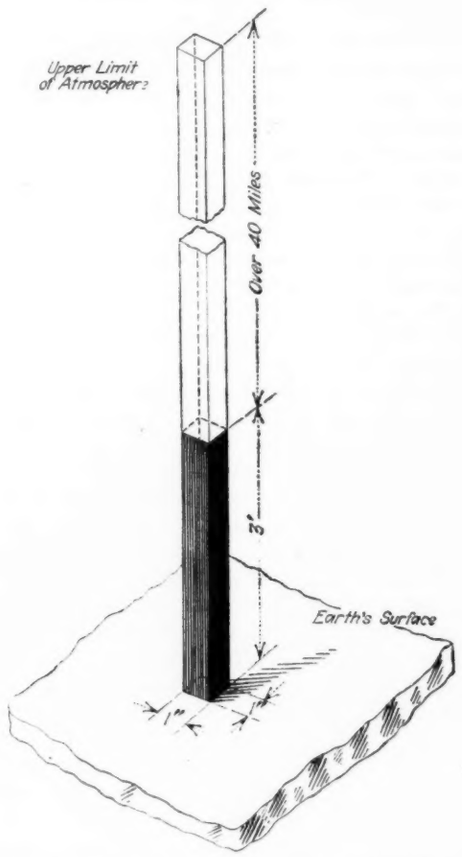
Per Cent CO_2	Pounds of Air	Per Cent CO_2	Pounds of Air	Per Cent CO_2	Pounds of Air
21	11.6	14	17.4	7	34.8
20	12.2	13	18.7	6	40.7
19	12.8	12	20.3	5	48.7
18	13.5	11	22.1	4	61.0
17	14.3	10	24.4	3	81.3
16	15.2	9	26.1	2	121.8
15	16.2	8	30.5	1	244.0

quantity of air that will give practically complete combustion. The indication of such result is, of course, high CO_2, as shown by the table.

It is a general mistake to give more thought to the fuel than to the air supply, in spite of the fact that from fifteen to fifty or more times as much air as fuel enters the boiler furnace. Air being invisible, many engineers and firemen do not appreciate how much of it they deal with daily.

A pound of carbon, the preponderant element of fuel, requires 11.6 lb. of air in theory for its complete combustion. Actually, it requires more because there must be a surplus of air to provide for the difficulty of mixing the air and fuel completely while burning. Forty per cent excess air should be sufficient for coal fuel. Therefore coal containing 10 per cent ash and burned with 40 per cent excess air would require about 14.6 lb. of air per pound of fuel.

We know that the pressure of the atmosphere on each square inch of the earth's surface at sea level is 14.7 lb. That means that all the air directly above a square inch of the earth's surface weighs 14.7 lb. The earth's atmosphere is estimated to extend up into the sky for a distance of over forty miles from the earth's surface. Such a column of air, then, one inch square and over 40 miles in height would be just about sufficient to completely burn a pound of coal if it could be brought in contact with the fuel. The pound of coal would occupy a volume of about 36 cu.in. or a column 3 ft. high with a one square inch base. Although the forty-mile (or more) column of air certainly makes the little column of coal look insignificant in comparison, it must be borne



A COLUMN OF AIR 1 IN. SQUARE AND EXTENDING UP TO THE END OF THE ATMOSPHERE IS JUST ABOUT ENOUGH TO BURN A POUND OF COAL

in mind that this proportion represents best conditions and in practice two or three times as much air is frequently employed, to the detriment of high efficiency.

A similar mass of air on the ground would, of course, occupy a smaller volume because of the greater and uniform density of the air at the earth's surface. Nevertheless that figure is correspondingly impressive. One pound of air at 62 deg. F. and atmospheric pressure occupies 13.14 cu.ft. Therefore, 14.6 lb. of air, the amount required to burn a pound of coal, would occupy 192 cu.ft. of space. Multiplying this figure by 144 gives 27,648 ft. (or 5¼ miles) which is the length of a column of air 1 in. square, of normal atmospheric density, required to burn one pound of coal (about 36 cu.in.). This air represents 9,216 times the volume of greatest quantity of coal which it can burn, namely 36 cu.in.

The Anderson Semi-Diesel Oil Engine

During the war the Anderson Foundry and Machine Co., of Anderson, Ind., was engaged in munition work and was unable to give any great amount of its manufacturing facilities toward the production of the Anderson Semi-Diesel oil engine. Considerable development, however, was done in the engine design. With the release from war work, the company has turned all its energy toward the manufacture of the K-type engine.

This engine is of the vertical two-cycle medium-compression surface-ignition type. Units of one, two, three and four cylinders are manufactured. The sizes range from 30 to 300 hp. The fuel consumption of 0.50 to 0.59 lb. per brake-horsepower, while higher than that of a Diesel engine, is sufficiently attractive to allow the engine in many plants to show a total over-all economy quite equal to the Diesel. This is especially true in those plants where the output is seasonal, as in cotton ginning or irrigation.

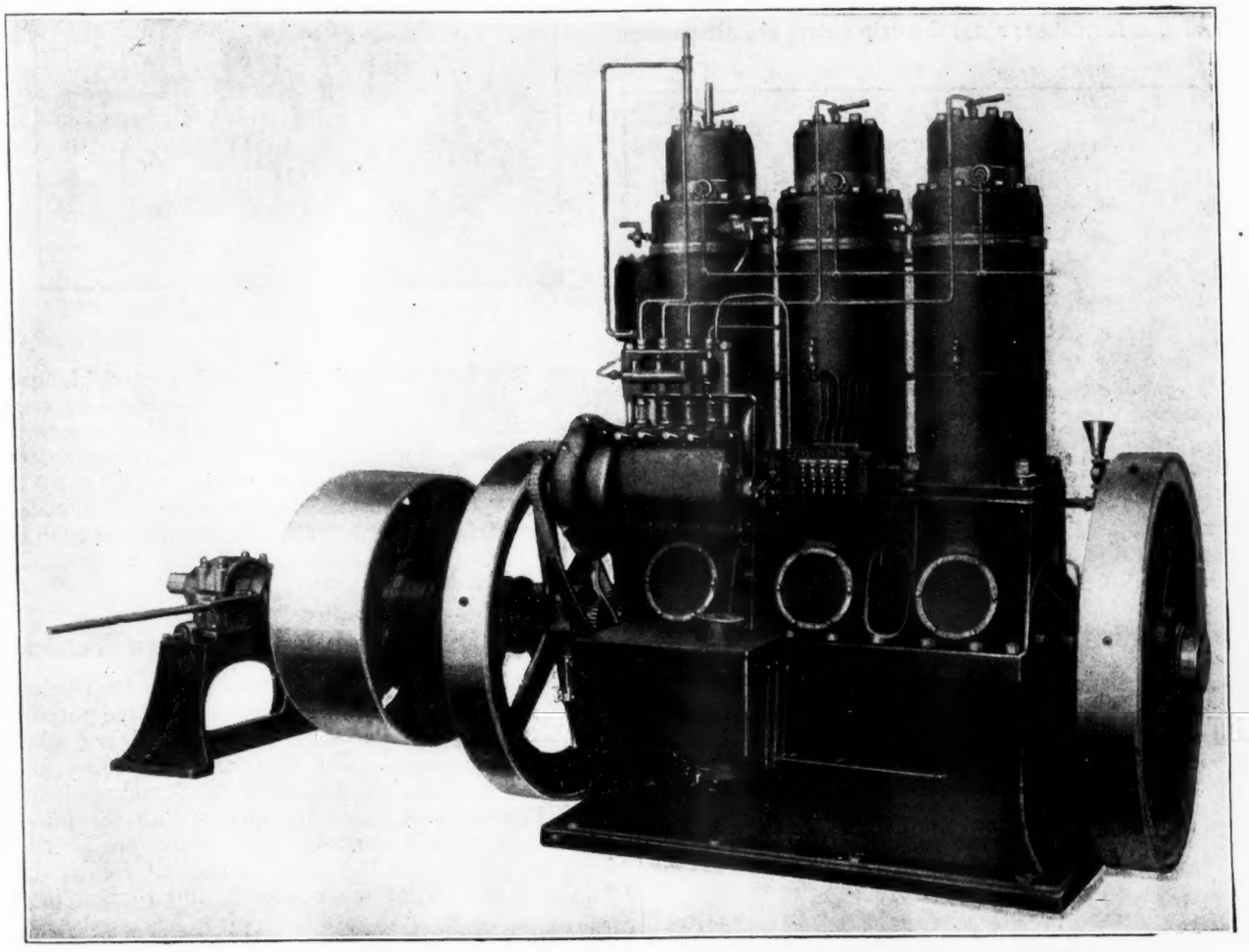


FIG. 1. ANDERSON VERTICAL, TWO-CYCLE, SURFACE-IGNITION SEMI-DIESEL OIL ENGINE

The bed of the engine, regardless of the number of cylinders, is of one-piece construction. The upper half of the crankcase or cylinder sub-base is a separate casting, being bolted to the base. The cylinders are bolted and doweled to the upper casting.

After the engine base and cylinder sub-bases are assembled, they are placed on a special horizontal boring mill. The crankshaft bearing housings are bored in correct alignment. The bearings are of the shell design with babbitt liners. Replacement of worn bearings is easily secured. Since the housings are true, there is no difficulty in maintaining the alignment of the journals.

The crankshaft is forged from a billet. The crank throws are provided with counterweights. To prevent the escape of the scavenging air along the crankshaft, air-seal rings are placed between the crank throws and the inner ends of the main bearings. The main bearings are provided with oil rings and oil cellars. Oil is led to the top of the main bearings from a mechanical pump. The excess from the main bearing drips into an oil ring leading to the crankpin bearings. After fulfilling its purpose the oil falls into the bottom of the crankcase; whence it passes into a filter and is used again. This circulation of the oil lowers the lubricating costs. The pistons and piston pins are lubricated from a separate mechanical lubricator.

The Anderson oil engine is of the so-called "dry type." No water injector is supplied to the working cylinder to keep the cylinder temperature below the preignition point during compression. As a consequence, the combustion space is confined to a spherical-shaped cavity contained in the cylinder head. Fig. 2 shows the shape of this combustion chamber. The cylinder head is in two parts; this construction facilitates the manufac-

ture and lowers the cost of replacement. The entire combustion chamber is water-cooled. In starting, a plug at the side of the combustion chamber is heated by a torch. The fuel is injected through a nozzle at the top of the head, and the oil spray is directed downward, toward the opening into the cylinder. A deflector consisting of a small stem with a blade at the bottom serves to direct the spray onto the starting plug. As soon as the engine has turned over a few times, the deflector is shifted, allowing the oil to spray downward.

The engine is capable of delivering its full rating without water injection. On overloads, if water injection is used, the engine can develop 30 per cent overrating. To give this reserve capacity, a water drip valve is furnished; since the drip enters the air passage

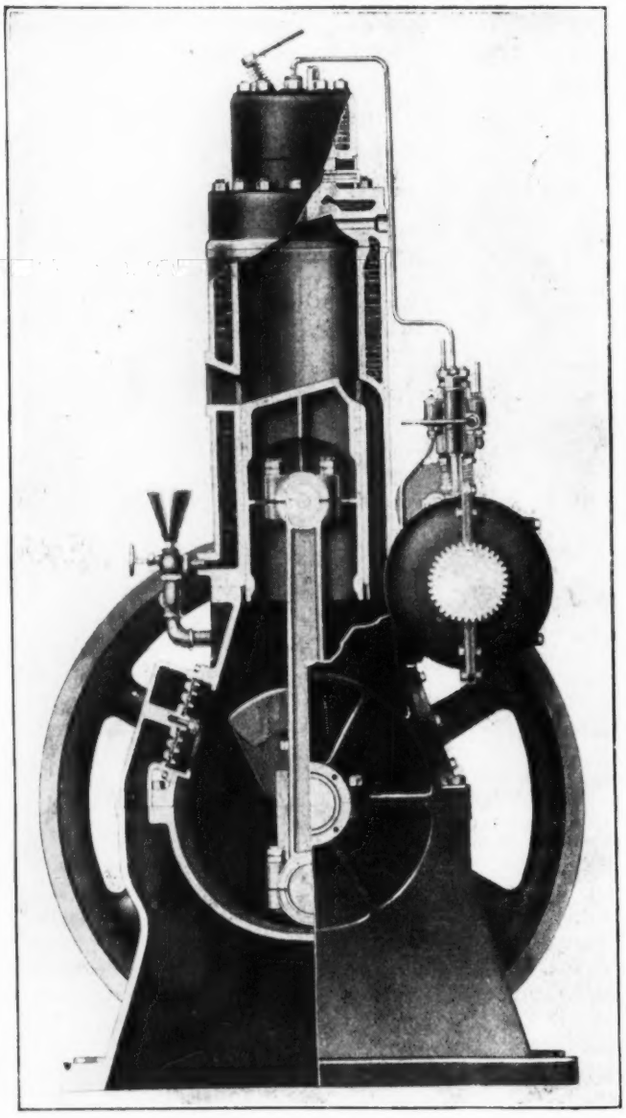


FIG. 2. ENGINE CROSS-SECTION

and not the cylinder itself, there is no danger of water washing away the piston lubrication.

The governor, with the fuel pump, is placed in a cast-iron housing at the front of the engine. The assembly is driven from the engine shift through a silent chain drive. The governor consists of a disc with two weights and arms. At a change of speed the arms shift the cam sleeve, which is mounted on the governor shaft and carries a cam for each engine cylinder. About the cam is placed a stirrup, as appears in Fig. 3. The upper end of this stirrup contacts with the fuel-pump plunger. The cam has a sloping face, so that a shifting of the cam sleeve alters the pump stroke. The

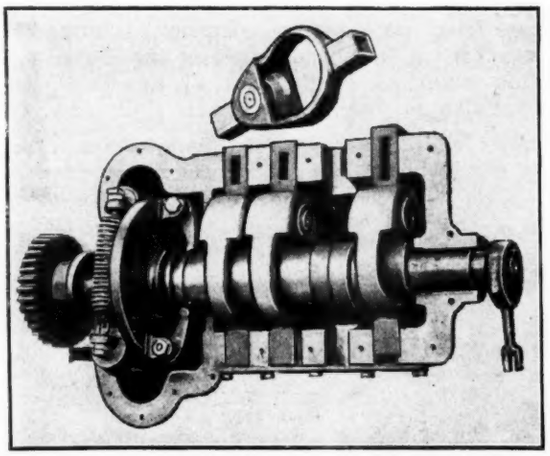


FIG. 3. GOVERNOR AND PUMP CAMS

pump is a bronze casting fitted with a steel plunger. Needle valves enable the amount of fuel entering each combustion chamber to be varied by the operator.

When direct-connecting to a generator, the generator shaft is coupled to one end of the engine shaft. For belt drive the engine is supplied with an extended shaft and friction clutch pulley. Many of these engines are in use in the oil fields, where a reversing clutch pulley is standard equipment.

Electric Drive Applied to Cargo Vessels

The United States Shipping Board has adopted electric drive for twelve new cargo vessels for the purpose of determining the relative advantages of this and other types of propulsion. The first of these ships, the "Eclipse," has been put through her dock and sea trials and will shortly be ready for service with the International Mercantile Marine. Electric drive has already been tried in United State battleships, but this is the first such installation to be made in this country in a

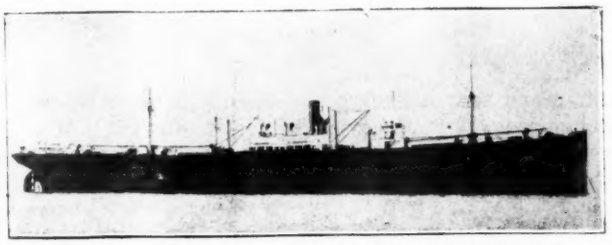


FIG. 1. THE UNITED STATES SHIPPING BOARD VESSEL "ECLIPSE"

general cargo merchant vessel. The matter is of more than passing interest because it is safe to say that future practice in the design of propulsion apparatus will depend to a considerable extent on the performance of these vessels.

The "Eclipse" is a vessel of 11,868 dead-weight tonnage, is 440 ft. long, and has a beam of 56 ft. It was

built by the Union Iron Works, of San Francisco. The present electric-propulsion machinery was designed and manufactured by the General Electric Co. and was installed by the Vulcan Iron Works, of Jersey City.

The driving machinery consists of a 3,000-hp. marine turbine-generator set which operates normally at 3,000 r.p.m., and a three-phase induction motor which drives the single propeller shaft at a normal speed of 100 r.p.m. This makes a total reduction between turbine and propeller speeds of 30 to 1. There are also two steam-engine-driven 125-volt exciters and a control equipment for maneuvering the ship.

The turbine is of the horizontal Curtis type and was designed expressly for marine service. It is controlled by a hydraulic variable-speed governor at speeds from 20 to 110 per cent of normal. The turbine is further provided with protective devices in the way of a centrifugal type pre-emergency governor controlling the speed up to 115 per cent of normal, and a ring-type emergency governor which prevents it from running at speeds exceeding 125 per cent of normal. It is direct-connected to the three-phase generator, which generates at 2,300 volts. This generator incorporates several features necessary to meet the particular requirements of the class of work that it is called upon to do. The stator consists of a cast-iron one-piece frame with openings in the top for ventilation. The core is built up of annealed segments of thin sheet iron of special material to insure low core loss and is held in place by heavy cast-iron frame flanges at each end. The windings are formed coils pressed from enameled cable, each turn consisting of rectangular copper strips in multiple. Eddy currents are eliminated by thorough insulation between the strips. Ventilation is provided by a centrifugal fan mounted at each end of the rotor.

The propelling motor is of the induction type and revolves at a normal speed of 100 r.p.m. It is ventilated by a motor-driven blower. The construction of the motor stator is similar to that of the generator stator. The rotor consists of a cast-iron spider keyed to the shaft on which the rotor core is assembled.

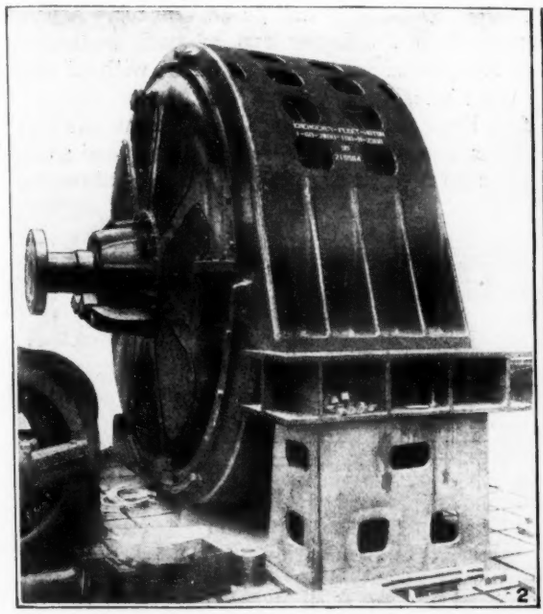


FIG. 2. THE 2,300-VOLT 3,000-HP. INDUCTION MOTOR

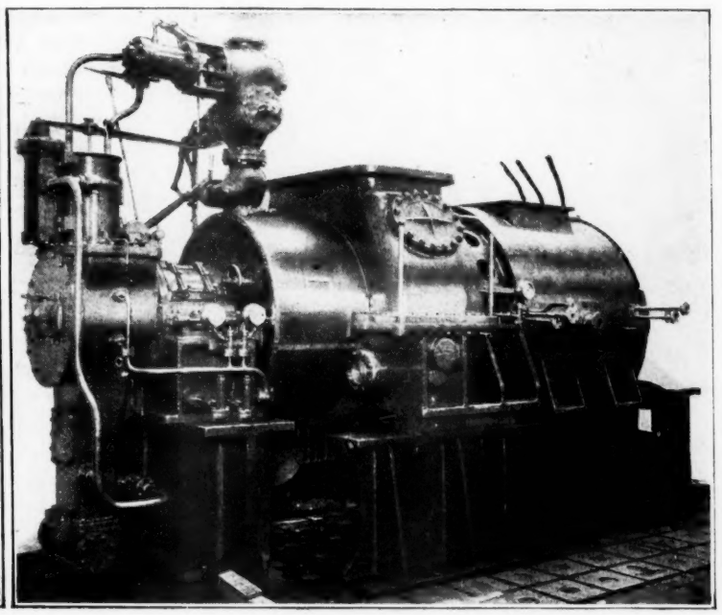


FIG. 3. MARINE TURBINE-GENERATOR SET

The control equipment comprises a control group, a water-cooled resistor and a control panel. The water-cooled resistor is inserted in the motor circuit when operating the motor at low speeds and is mounted on top of the control panel. The panel is a structural-iron cell, faced on one side by a sheet-steel plate upon which are mounted all the electrical instruments and the electric and speed levers for normal operation of the machinery. The electric and speed levers are mechanically interlocked, to prevent improper starting and running conditions. The electric lever moves the master controller, which in turn energizes the contactors of the control group, normally operated by solenoids. In addition to the speed and electric levers there is a field resistor for regulating the generator field resistance, and an auxiliary handle for operating a fuse disconnecting switch in the control circuit leading from the 125-volt power supply to the master controller. There are also levers for connecting either exciter into circuits, two exciter resistors (one for each exciter) and levers for connecting the blower and generator field to the exciter bus. If for any reason it should become necessary or desirable to operate the control group manually, it may be accomplished by means of three levers mounted

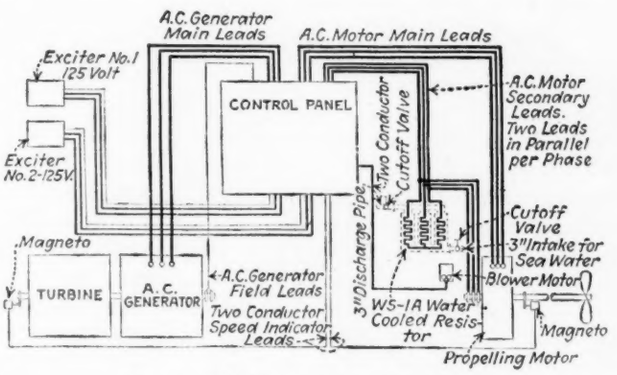


FIG. 4. DIAGRAM OF THE WIRING

to the left side of the control panel. These levers, the resistor lever, the field lever and the reverse lever actuate the contactors directly by means of cams.

No conclusions may as yet be drawn from this installation relative to application of electric drive to

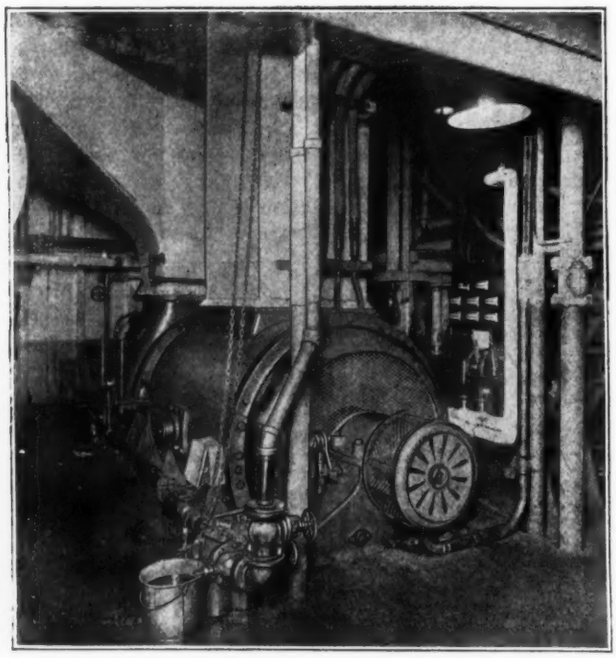


FIG. 5. TURBINE AS INSTALLED IN THE SHIP

cargo vessels, but when the "Eclipse" has been in service for a while, the results of its performance should prove decidedly interesting.

Twin Strainer and Water Separator for Gasoline-Engine Fuel Line

BY H. H. PARKER

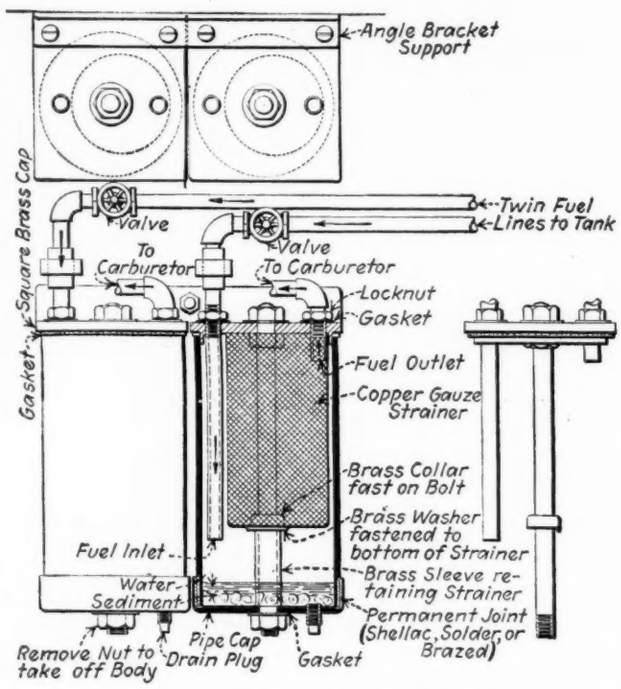
The sketch shows a twin strainer originally designed for a heavy-duty marine-engine installation, but which would also be applicable to stationary work where gasoline, distillate or kerosene is used as fuel. The combination of shutoff valves and unions is such that either separator may be removed for cleaning or repair without disturbing the other or without interfering with the operation of the engine.

Two square brass plates with circular countersunk bottom bosses are faced off to take the strainer bodies, preferably made of brass pipe of as large diameter and length as practicable; the larger the strainer the longer it will run without cleaning. The two top plates are held together and bolted to a bulkhead or other support by means of a steel angle plate; if a large lathe is handy for the machining, but one top plate with two bottom bosses and cast supporting brackets would be best.

The lower end of each strainer body is closed by a pipe cap set in shellac, soldered or brazed permanently in place. The upper end is accurately faced and presses against a leather, cork or lead (not rubber) gasket, this gasket being pressed on the top plate and set in shellac. A through bolt, preferably brass, with lead gaskets under the nuts, holds the body in place, but the whole may be quickly removed by loosening the lower nut. A copper-gauze strainer is made up as shown; a stiffening ring soldered around the top edge and a brass washer to the bottom, through which the bolt fits. A brass collar above, fast to the bolt, and a loose brass sleeve, slipped over the bolt from below, hold the strainer in place, but allow of easy removal after the body is taken off.

As shown, the strainer is smaller in diameter than the inside of the pipe body, as the fuel intake pipe does not enter it, but comes down one side within about two inches of the bottom. The outlet pipe, though, is within the strainer and is short. Both pipes are fitted with running threads, screw up through the top plates and are secured by locknuts and gaskets on top. A pipe plug screwed into the lower cap of each separator allows the removal of water and sediment without dismantling the whole.

Twin fuel lines to the tank are shown, but one line and the proper arrangement of tee and unions and shutoff valves can be used just as well. The fuel enters the



SHOWING DETAILS OF TWIN STRAINER AND WATER SEPARATOR

separator near the bottom, and any sediment and water will quickly settle where it can be occasionally drawn off. Floating sediment will not be able to enter the intake pipe, owing to the strainer, and as this is of large area it will not be easily clogged. Furthermore, the outlet pipe is near the top and therefore out of reach of all impurities.

In making up such a separator, the chief point to be looked to is to keep all joints gasoline-tight by the use of gaskets and shellac. Before replacing the separator body, it would be well to scrape a bar of yellow soap over its upper edge and set this layer of soap up against the gasket.

EDITORIALS

The Oil Situation

THE public, while showing alarm over the diminishing petroleum supply, are inclined here, as in all other phases of economy, to "let George do it." If each owner of a "high-powered" fifty to eighty horsepower automobile could be made to feel his personal responsibility when his car turns but five miles per gallon of fuel, instead of twenty to thirty miles as it should, he would show less interest in acceleration and more in economy.

The same inertia possesses the artificial-gas manufacturer. No logical excuse exists for the use of oil in "fixing" gas. Candlepower is no longer the characteristic to be used in determining the value of a gas; the heat content decides the actual value, and this in no way is increased by "fixing." One of the first steps in oil conservation is the abandonment of its use in gas plants. The change in the plant equipment is by no means great.

E. T. Adams, in his article on "The Oil Situation," which appears on another page, discusses these points as well as the influence the oil supply will have on oil-engine design. As he brings out, the tractor requirements will be enormous in a short time and the manufacturers should anticipate the future shortage of gasoline and design engines to use heavy oil. While heavy oils such as kerosene and distillates are not unqualified successes in automobile engines, satisfactory performance should obtain in tractor use. This is for the reason that in tractor work the engine is always loaded, so does not experience the temperature changes occurring in an automobile engine.

The world has been warned of the oil shortage that will exist if steps are not speedily taken to cope with the situation. It is no longer a problem to put up to George to do, but concerns each individual, both manufacturer and consumer. Economy should have been practiced in the past; it must be enforced in the future.

Conservation By Interconnection

FOR several years past the country has been subjected to periodic fluctuations of its coal supply in the face of a steadily increasing demand for power. Obviously, this demand will continue to increase, and unless economy and conservation are speedily effected the fuel situation will become more acute year after year.

Under the stimulus of war, and with constant pressure exerted by the Fuel Administration, phenomenal savings were secured while the conflict lasted, but with these factors removed and business flourishing, a tendency arose to relax vigilance at the coal pile. Educational propaganda will accomplish much, but without supervision or some such incentive it is unreasonable to expect an approach to war-time economy. There are, however, large wastes that are beyond the control of the operator; they are inherent in the layout of the plant or system or the conditions of load.

The investigation now being conducted by the Superpower Survey shows that there is approximately seventeen million horsepower installed capacity in the Washington-Boston zone, operating at a power factor of approximately fifteen per cent; the central stations alone, owing to the low power factor, averaging a coal consumption of four and one-fifth pounds per kilowatt-hour. By interconnection the power factor could be raised to fifty per cent and the fuel consumption cut to nearly one-third. W. S. Murray, chairman of the Superpower Survey, has estimated that a system of interconnection and electrification would effect a saving of thirty million tons of coal annually in this zone alone.

Recent investigations of the St. Lawrence project indicate an available supply of one million horsepower on the American side, which, according to estimates of the engineers, could be transmitted to the New York district, a distance of three hundred miles at a loss of not more than ten per cent and at an initial investment, including transmission lines, power house and substations of two hundred million dollars.

California has led the way in interconnection of power systems and has tied together practically every system within the state. Only by such means was it possible to cope with the power situation on the Coast.

Interconnection, however, must not stop with central stations; it should take into account the industrial plants, aiming wherever possible to run the industrial plant at its most economical heat balance supplemented by central-station service. In this way only can there be the greatest conservation of coal as relates to its use for power generation.

Testing Welds

HOW to know when a weld is made properly is one of the problems, which up to this time the autogenous welding engineer has not solved. Although many suggestions for testing welds have been made, none of these has offered a complete solution. The manufacture of iron and steel is generally done in such quantities that where necessary the process can be carried on under the supervision of an expert, therefore conditions are favorable for the product having a uniform quality. And if tests are made on a few samples of a given lot, it is a good barometer as to the quality of the whole product. But with autogenous welding the quality of the metal in the weld depends very largely upon the man who did the job The metal is deposited drop by drop, and every drop affords the welder an opportunity to cause a defect in the weld by allowing a variation of any one of the many factors under his control. Therefore even if one weld or a section of a weld is tested, the result is not an insurance that another made by the same man is of equal quality. All who have had experience with the failure of welded pressure vessels have seen the weld fail at some weak point only a few inches from where the work was properly done. When tests are made on such a weld, if they happen to be in the good section the whole is passed

as having high quality. Therefore the ideal way would be to test the whole weld, which obviously is practically impossible without destroying it, and this is just what is not wanted.

In a paper on "Testing Welds," recently presented by S. W. Miller before the Chicago section of the American Welding Society, an abstract of which is published on page 719 of this issue there are outlined a number of methods for testing welds. Among these are tests made on samples of welded bars which are subjected to tensile, bending, alternating-stress tests, etc. Such tests will give a good indication of whether a welder can make a good weld or not and the percentage of such welds that he can make which will come up to a certain standard, and in training welders these tests serve a useful purpose. However, if the welder has passed one hundred per cent on making these sample welds, whether in bars or plates from which samples are cut, it is no guarantee as to the quality of his workmanship when doing routine work day after day, and these are the welds we are chiefly interested in. The acid test referred to by Mr. Miller apparently could be so developed that it can be applied to almost any part on the surface of a weld. Although this would not show all that is desired, it would give a fairly good check on the quality of the welder's work and, combined with microphotography, would give a reasonably good record of the weld.

Why Exempt Oil-Country Boilers?

ABOUT a year ago the State of Oklahoma adopted the A. S. M. E. Boiler Code, placing the administration of the law in the hands of the State Labor Commissioner. It now develops that the manufacturers and jobbers handling the type of boilers used in the oil fields have advised the operators and purchasers that the A. S. M. E. Boiler Code is going to work a great hardship upon them, and the Commissioner of Labor has been requested to meet in conference with the Mid-Continent Oil and Gas Association to see if it will not be possible to make an exception in the case of the oil-country type boiler.

Meanwhile the secretary of the Boiler Code Committee has been approached as to whether there is an appreciable difference in cost between the existing type and that built in accordance with the A. S. M. E. specifications; whether the former is reasonably safe for oil-field use; and whether compliance with the Code would be likely to hold up delivery. In order to gain a representative opinion upon these questions the secretary addressed letters to a number of well-known manufacturers of such boilers, soliciting their opinions. The replies are most interesting. Out of eleven that have been received to date, the estimated increase in cost ranges from none at all to forty per cent. Only three of the manufacturers believed that compliance with the Code would hold up delivery. The majority believed that the existing type was reasonably safe for oil-country service, especially when used out in the open field, although a couple expressed the opinion that an A. S. M. E. Code boiler would be much safer. Two of the manufacturers did not hesitate to say that the existing type was not reasonably safe.

That certain of the local builders and jobbers are exerting every effort to create opposition to the Code is evidenced by the following quotation from a current issue of the "Daily Oil Bulletin" from *Petroleum Age*:

Tulsa, Okla.—Oklahoma oil men are preparing to give battle to protect from condemnation some ten thousand boilers in use in the oil fields of the state. They are valued at $8,000,000. Under the A. S. M. E. Code, governing boiler inspection, they would be valuable chiefly as junk. The Mid-Continent Oil and Gas Association seeks to have them exempted, as the boilers have been in other oil states.

Right here there appears to be an attempt to befog the issue. It will be recalled that when the A. S. M. E. Boiler Code was promulgated, it was recognized that the rules for new boilers would necessarily work a hardship on those already installed, and therefore special provision was made for existing boilers with the idea that in time these boilers as they wore out would be discarded or the allowable pressure so reduced as to eliminate the risk. Therefore, existing boilers in Oklahoma would be affected only to the extent of being inspected as to proper fittings, etcetera, and would be condemned only when in a dangerous condition.

Certain states that have adopted the A. S. M. E. Boiler Code have exempted oil-country and agriculture boilers with the exception of periodic inspections. Undoubtedly in some cases this has been an expediency resulting from political influence and is most unfortunate, especially when it is consdered that many of these boilers are of lap-seam construction and are operated by very unskilled labor. It is true that their usual location minimizes the hazard to life and property as compared with boilers installed in industrial centers. Nevertheless, many of these boilers do explode and the loss of life is appreciable.

It is the fixed policy of the A. S. M. E. Boiler Code Committee not to recommend or approve specific designs or types, but merely to pass upon safe construction as set forth in the Code, which represents the combined opinions of the best authorities in the country. Those having to settle the question in Oklahoma should bear this point in mind.

Supply and Demand

MANY IDLE SHIPS PUT INTO SERVICE

More Coal Cargoes Offered Than Can Be Taken Care Of, It Is Declared

(Special to *The World.*)

WASHINGTON, Oct. 24.—The coal miners' strike in England is having a wide effect on American shipping. The walkout already has stimulated shipping in American bottoms to the extent that scores of vessels that had been tied up because of no cargoes are again at work.

The effect is especially apparent in the coal trade. It is stated here that shippers have been offered more coal for export than can be accommodated on the vessels now available, despite the fact that much of the idle tonnage has been put into service.—New York *World*, Oct. 25.

UNSOLD COAL IN THE CITY NOW DOWN TO 70,000 TONS.

Health Commissioner Copeland Says Orders Placed for 1,500,000 Tons Cannot Be Delivered

Health Commissioner Copeland said yesterday the Health Department's coal survey now shows that there are only 70,000 tons of unsold coal in the city and that all of this is needed at once. Orders aggregating 1,500,000 tons which have been placed, cannot be filled, he said.—New York *World*, Oct. 25.

CORRESPONDENCE

Where Should the Beginner Start?

It is somewhat difficult to define the qualifications of a first-class fireman and suit everybody. There are some who will study the best way to burn coal and get the most out of it, but such men are scarce and they do not remain firemen long as they generally get something better.

My idea of a combustion engineer is one who makes a special study of combustion factors in various plants and who designs furnaces to meet the existing conditions. A boiler-room manager must be a good fireman, a good boiler repair man and a generally good mechanic in all work pertaining to boilers, accessories and auxiliaries.

If a man wants to become a first-class fireman, he should go into the marine service and fire until he can get a marine engineer's license from Uncle Sam. Then he can say he is a fireman. About the poorest place for a man to learn to become a first-class fireman is in a stoker-fired plant. S. H. WINTERS.

Albany, N. Y.

Suction Lift of Pumps

On page 553 of the Oct. 5 issue of *Power*, C. W. Peters writes that he has seen a piston pump deliver water taken from a level of thirty feet below it. As he has seen it done, that settles this particular case. Every engineer knows what the theoretical lift is, and most engineering books dealing with pumps explain this matter. In practice theory will often fail to come even near the given result. I have installed hundreds of pumps, but the best of them would not give a satisfactory supply of water if the supply level was more than twenty-seven feet below the pump piston or plunger.

In many cases where the lift was under thirty feet, the pump had to be lowered several feet to get a proper delivery. With all pipe joints tight and the pump in first-class condition I at one time succeeded in delivering water with a lift of nearly twenty-nine feet, but the pump plunger would jerk violently at the end of every stroke and the delivery was under 40 per cent of what it should have been to be satisfactory; lowering the pump three feet made it easy working and satisfactory in the quantity of water delivered.

Various writers have brought up the idea shown in Mr. Peters' fifty-foot lift. After reading such a description some years ago, I tried it out with a new iron hand pump and a forty-five-foot lift, starting with a ½-in. hole and gradually increasing the diameter. I failed to get results up to the point when the hole was ⅜ in. Then I gave it up and did not succeed in getting water to the pump.

The holes were made at the water lever so that both water and air would be taken into the suction pipe at each stroke. Probably the idea was first suggested from knowledge gained by air-lift experience, but the conditions are not the same in both cases. It may be possible to raise water fifty or eighty feet with a reciprocating or rotating, so-called, suction pump, by removing the air pressure from the top of the water and allowing air to mix with the entering water, but I have some doubts as to its success and I should like to hear from someone who has seen the experiment successfully demonstrated. It is noticeable that none of the writers describing this method have made any claim to have seen such a fifty- or eighty-foot lift in operation. JAMES E. NOBLE.

Portsmouth, Ont., Canada.

Commutators Made from Copper Block

Noting an article in the Sept. 21 issue of *Power*, page 458, by Vernon Pearson, on the building of small direct-current commutators, also a warning of patent infringement, on page 591 in the Oct. 12 issue, by H. E. Weightman, I am moved to call your attention to the following facts:

In April, 1900, I was, on account of business relations, permitted to have access to all parts of the factory of the Eck Motor Works, which at that time was located in the Atlas Power Building, Newark, N. J. This firm made direct-current fan motors, also motors for automatic pressure apparatus; in fact, their business was solely in direct-current motors of sizes up to five horsepower.

The stock from which the commutators were made was hard-drawn copper, and, in some instances in the larger sizes, rolled bronze. This material was received in the proper diameter, and put through special machinery for slotting and boring. As I remember, both operations were made on the same machine, the stock feeding through a hollow spindle. After the boring and slotting it was received in a container and taken to the filling room, where the mica and insulating bushing were applied. The commutator bars were not finally separated until the commutator was permanently insulated, bound and baked. What made such an impression

on me was the speed of the process compared to the very slow way where the commutator was built up bar by bar on a form, then pressed into shape and finally baked and machined.

I am not familiar with the patent laws and have no desire to enter a controversy, but am writing this that it may perhaps shed some light on a long-forgotten process.

WILLIAM J. CUMMINGS.

Haskell, N. J.

How an Engine Bearing Shell Was Lengthened

Recently, we had to make some repairs on a 10 x 12-in. high-speed automatic engine running at 300 r.p.m. Among other things the main bearings needed attention, and as one of them was in bad shape a spare set of shells was made ready. One of them required a little scraping, but the other was found to be ¼ in. short. It was decided to make a wooden mold and pour babbitt onto the end of this short shell, which was plain except for a lip at one end, as shown in Fig. 1.

Two pieces of 1¾-in. stock were sawed out and fitted to the inside and outside of the shell, Fig. 2. Then a rabbet was cut around the arc of the wood block forming the outer part of the mold. Several bores were drilled in the end of the shell, and the surface was

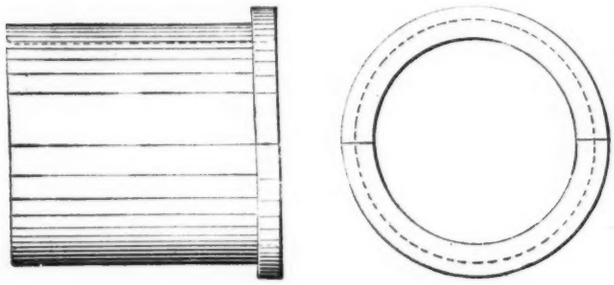


FIG. 1. BEARING SHELL, LIP AT ONE END

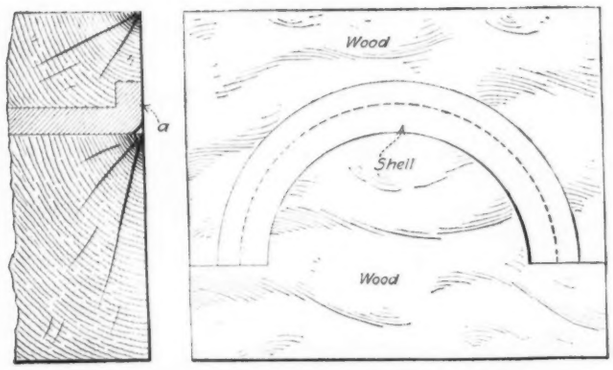


FIG. 2. SHELL FITTED TO WOODEN MOLD

carefully trimmed. The blocks were fastened in place with a wooden hand clamp, after which the babbitt was poured.

The same blocks that were used as a mold for the babbitting job came in very nicely for holding the shell while the end was being filed and fitted. Fig. 3 shows the shell being held in the vise with its axis horizontal. When it was desired to hold it with the axis in a vertical position, the blocks were clamped around the babbitted shell with a wooden hand clamp and the jaw of the screw was gripped in the vise. The shell was so long that it would not be held firmly enough were the blocks gripped in the vise—the lower end of the shell projected below the screw of the vise as shown in Fig. 4.

While placing the shells in the engine and fitting them, top shells persisted in dropping out of the top castings of the boxes while they were being raised and

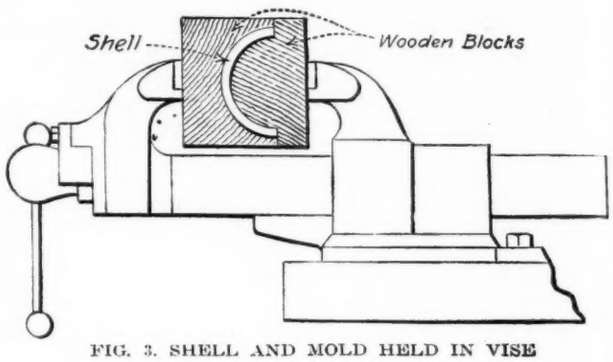


FIG. 3. SHELL AND MOLD HELD IN VISE

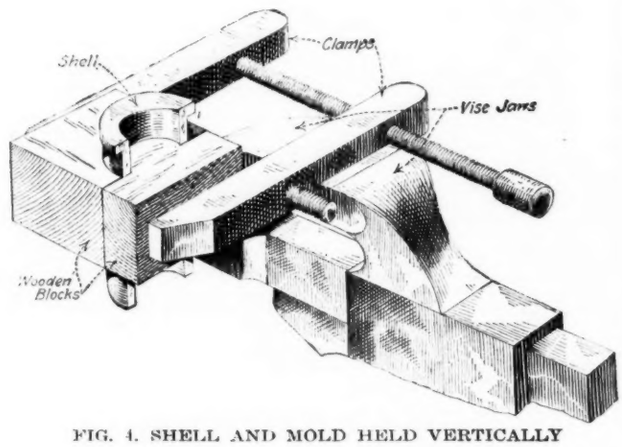


FIG. 4. SHELL AND MOLD HELD VERTICALLY

lowered during the process of fitting. The "chief" solved the problem in short order by slapping some cup grease into the box and pressing the shell into it. The suction prevented the shell from dropping out. After the fitting had been done, each upper shell was pinned to the top section of the box to prevent the shell from turning, which has caused difficulty with the bearings on this engine, as when the shells turned they did not get enough oil.

JOHN D. EBERHARDT.

Arlington, Mass.

Engine Thumps and Pounds

Reading the letter of A. C. Waters, on page 515 of the Sept. 28 issue of *Power*, regarding engine thumps recalled a couple of experiences I ran up against. The first was with a Corliss engine in a lumber mill. One day a regular steam-hammer thump let loose. Upon shutting down, no loose parts were found, but after starting up again and while feeling the crosshead, I discovered that the locknut on the piston rod was three complete turns loose. After setting it up and checking for piston clearance on each end, everything was all right.

The second instance was with a straight-line engine, built with a Y-shaped frame and on the three-point

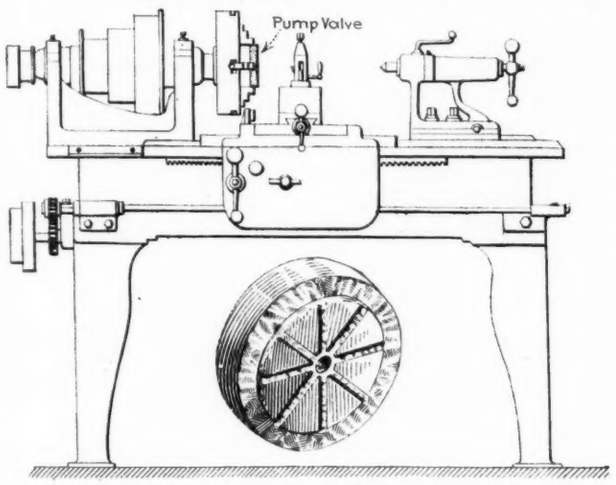
suspension idea. The cylinder is on one leg and the frame ends on the other two. The two flywheels are between the frames and just far enough apart for the crank. One wheel carries the governor. The crosshead is designed just opposite to most crossheads, as the pin is held rigid in the end of the rod and oscillates in the crosshead, which is of the slipper type. On each side of the rod are fiber rings around the pin. The rod must have a certain amount of side play at the crosshead and wheel end. I had one of these engines, and when it ran with light load it would rattle away for dear life. This was because the weight on the governor hit the rim of the wheel. But the thump was caused by the slipper guide being loose.

I have seen men look all over a straight-line engine for a knock when it was in the bushing that takes the place of packing. These engines have no packing on either rod, but have a long metal bushing. If screwed up too hard, these bushings break with a resulting pound. R. G. SUMMERS.

Geneva, N. Y.

Refacing Pump Valves

A wrinkle for refacing pump valves is as follows: Put them in a small lathe, turn them up with a facing



REFACING PUMP VALVE IN LATHE

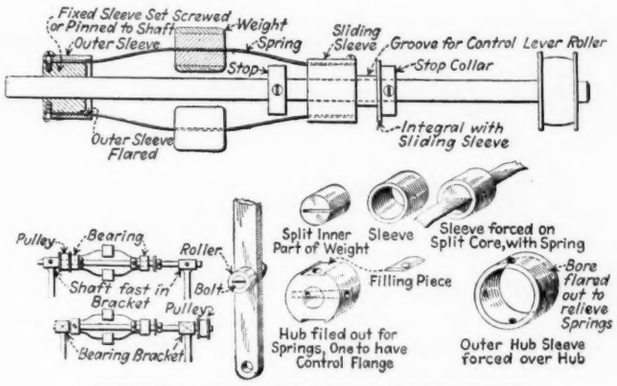
tool and finish with a block of wood covered with No. 00 or No. 1½ sandpaper. This is quicker than handwork and makes just as good a job. R. G. BROWN.

Geneva, N. Y.

How to Make a Simple Gas-Engine Governor

Frequently, an internal-combustion pumping, vehicle or marine engine is adapted to stationary purposes, where the load is constantly changing. In this case a governor is required, which, even if it does not regulate as accurately as a specially designed one, can be relied upon to keep the engine from racing or stalling. Small marine engines, even of the heavy-duty type, are not always supplied with governors, and the throttle must be closed before throwing out the clutch; a governor would be of considerable value here also.

The sketches show the construction of a small governor of the Pickering type on which but little lathework is required. The size will depend on the speed at which it is to be driven and the amount of pull required to move the throttle valve, which will be of the plain butterfly type. The higher the speed the smaller the weights required or the stiffer the springs. Two brass or steel hubs are turned up and reamed to fit the driveshaft and filed off to take the governor springs. Two, three or four springs and weights can be used, according to requirements; heavy clock spring will answer the purpose for a small governor. The ends only of the springs are drawn; then they are held in place and sleeves driven on over them and the hubs; holes are drilled through the sleeve, spring and hub and tapped for machine screws. The inner ends of the outer sleeves should be flared out to relieve the springs when



DETAILS OF GOVERNOR CONSTRUCTION

the weights are all the way out. One hub is pinned or keyed to the shaft, while the other is a sliding fit and is provided with a grooved flange to take the control-lever roller; or else the shaft is fixed in place and the two hubs revolve on it, one having the drive pulley or gear integral with it and held between two collars which are fast on the shaft.

The springs are not drilled for the weights, as this would weaken them; instead, each weight is built up of an inner piece, slit almost through with a hacksaw to take the spring, and an outer sleeve forced over the inner part and spring, thus holding both tightly together. The weights may be brass or steel. A stop collar on the shaft is necessary to limit the amount of governor opening, otherwise the springs might buckle; in any event, there should be no great strain on the springs when the weights are all the way out.

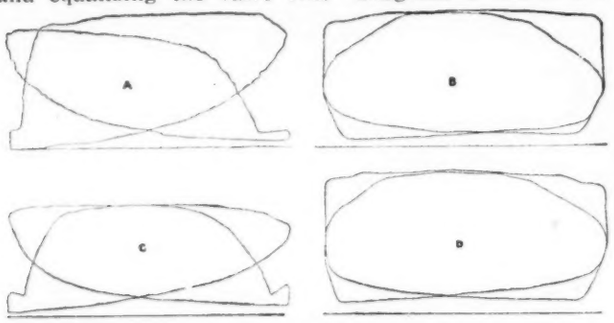
The easiest way to arrange the control lever is to attach a small brass roller to it, running on a steel stud; the roller fits into the grooved flange, and it and the lever are pushed back and forth as the governor weights move in or out. I used such a roller and lever for several years upon a marine engine with perfect success, though a split yoke would be more nearly mechanically correct. For a governor of this type a simple butterfly valve and lever, in the intake pipe, is probably best, though in many cases connection can be made directly to the throttle lever on the carburetor.

A positive drive is best, by gear, sprocket or direct coupling to cam or pump shaft; a round or flat leather belt will operate the governor well enough, but care must be taken to close the throttle independently when leaving the engine unattended, for if the belt broke there would be disastrous racing should the throttle happen to be wide open. H. H. PARKER.

Oakland, Cal.

Steam Loss Caused by Faulty Valve Adjustments

The accompanying diagrams were taken from a pair of 26 x 48-in. direct-connected coal-shaft hoisting engines, fitted with balanced slide valve. Diagram *A* shows the conditions of valve adjustments of the left engine as I found it upon first indicating. Diagram *B* shows the results after advancing the eccentric 32 deg. and equalizing the valve rod. Diagram *C* shows the



EFFECT OF CHANGING ECCENTRIC ON TWIN HOISTING ENGINE

conditions of valve adjustment of the right engine as found upon first indicating. Diagram *D* shows the results after advancing the eccentric 22 degrees.

The average steam consumption per horsepower calculated from diagrams *A* and *C* was 49.69 lb., and that calculated from diagrams *B* and *D* was 32.99 lb., which shows a saving in steam of 16.7 lb. per horsepower-hour. C. J. HALLORAN.

Avoca, Pa.

Coal Prices Here and Abroad

I recently read an article in an English engineering paper in which it was stated that the price at which imported coal is being sold in England was causing a most unpleasant awakening among the English coal operators and dealers.

In the years preceding the war England exported 70,000,000 tons of coal per year, exclusive of bunker coal supplied to outgoing steamers, and the British merchant service was largely used in transporting this coal to all parts of the world. Since the war, however, England has been importing coal; but what jars them is the fact that, according to the item, English-mined coal stands the purchaser $9.92 per ton, while American imported coal is being offered at $4.57 per ton, f.o.b.

The item does not state whether this coal is f.o.b. at an American port or at an English port, but assuming it to mean that the quoted price is f.o.b. at an American port, the question arises, How can coal be sold at such a price? According to newspaper reports bituminous coal is bringing around $8 per ton at the mine in America. How, then, can it be loaded into a vessel for export at a rate of $4.56 per ton?

Of course this price represents a satisfactory profit to the shipper, and if so, there is a difference of $3.44 per ton added to coal for domestic use. With an additional charge of about $8 or $10 per ton the American consumer seems to be "getting it in the neck."

If the Department of Justice is looking into the coal situation as regards profiteering, why not ascertain why coal can be shipped to England at a price that is $3.44 less than operators are getting at the mine for coal used by American steam plants? A. W. JACOBS.

New York City.

Steam-Heated Fuel-Oil Pipe Line in Underground Conduit

No sooner does one do something that he believes to be original (and therefore considers himself entitled to a little glory) than someone else bobs up to state that he did it long ago. It is doubtful whether the second someone acquires any glory; but rather he may be relegated to the ranks of the I-told-you-sos and the I-did-it-firsts.

In the Oct. 12, 1920, issue of *Power*, page 580, is a description of a steam-heated fuel-oil pipe line in an underground conduit, supposedly the first installation of the kind. Thoughtfulness would require me to keep silent as to any historical notes bearing on this article, but for the good of the art let me say that there has been in use for a year or more an underground oil-pipe line 900 ft. long, about two-thirds of which is run in ordinary tile pipe split in two and then put together again.

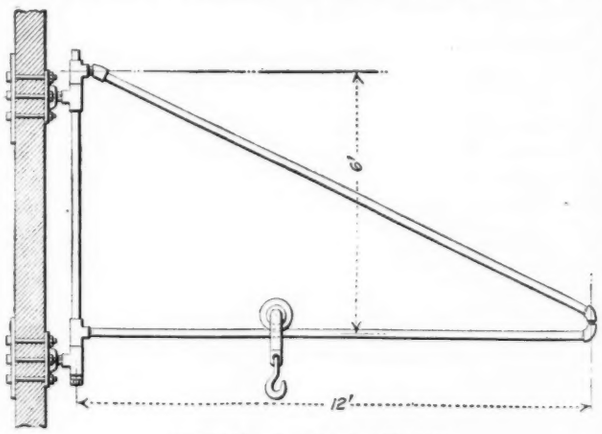
The line is of standard 6-in. pipe, laid on roller chairs, similar to those described in the article, and the steam pipe for keeping the oil warm is run inside of the 6-in. oil pipe, so that all the heat is taken up by the oil, making the problem of insulating the oil pipe itself a comparatively simple one. As a matter of fact, it has been found that for a very considerable portion of the year it is not necessary to use any steam, and that the oil can be pumped from the storage tank to the service tank without further heat than that taken up in the exhaust-steam heaters attached to the pump.

This line has been in use twenty-four hours a day and, so far as I know, has never given any trouble.

Providence, R. I. WARREN P. LEWIS.

Home-Made Wall Crane

The wall crane shown is not difficult to build and will prove useful in the repair department of a power plant or machine shop. It should be made from extra-heavy iron pipe and malleable or steel pipe fittings. A piece



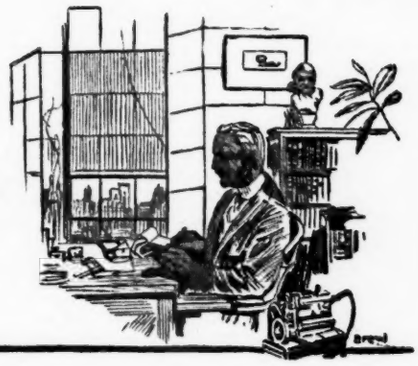
DESIGN OF WALL CRANE

of 2¼-in. iron bar makes a neat fit inside an extra-heavy pipe fitting. A piece of iron plate can be used back of the wall at the bolt heads.

Such a crane will handle weights up to ¾ ton. A chain or rope tackle can be used to raise the material handled. The carrying arm should be level. A plug is screwed into the bottom tee to prevent the bar from falling through. JAMES E. NOBLE.

Portsmouth, Ont.

INQUIRIES OF GENERAL INTEREST



Smoky Exhaust of Diesel Engine—Will low injection air cause my Diesel engine to smoke? G. M.

It will, especially if the engine is fully loaded. Air pressure below 50 atmospheres will often cause a smoky exhaust.

Gumming of Compressor Valves—What causes Diesel air-compressor valves to gum? P. R. C.

Gumming results from using too much lubricating oil. Two drops per minute per cylinder is ample for the average-sized compressor.

Time for Blowing Down Boilers—When is the proper time to blow down a boiler, when banked or when steaming at a high rate? T. B.

If the water is very muddy, the boiler should be blown down several times a day and preferably during intervals like morning, noon and night, when the boiler is doing the least steaming. If blowing down is done only once a day, the best time is in the morning or after the longest interval of rest and before the settled sediment becomes too much stirred up by the circulation during active steaming.

Imperfect Diesel Indicator Diagrams—With new fuel cam noses put on a Diesel, it is found that the indicator diagrams are very sharp, showing no admission lines. Is this caused by the new cam noses? H. C. C.

The new noses may give too great a lift to the fuel needle valve, allowing the oil charge to blow into the cylinder at once. Try giving the fuel rocker arm less clearance, which would cause the needle to open earlier and slower. Lowering the injection-air pressure often flattens the card. Your timing may be too early; if so, the maximum pressure will be above normal.

The "Locomobile" Power Plant—Why is the locomobile type of power plant so called, and what are the reasons for its superior economy? R. L.

The name "locomobile" came from the fact that as originally made these power plants were mounted on wheels and intended for portable use. The high economies are due to the precautions taken in their design to guard against initial condensation and to minimize loss of heat in the flue gases and the exhaust steam. The more economical plants are operated compound condensing. Steam generated in the boiler is passed through a superheater suspended in the smoke box with the direction of steam flow so arranged that the hottest steam is heated by the hottest gases. The steam then passes through a pipe within the flue to the high-pressure cylinder, which is jacketed by the hot flue gases. From the high-pressure cylinder the steam passes to a reheater receiver contained in the smoke box and is thence admitted to the low-pressure cylinder, exhausting through a feed-water heater to the atmosphere or to a condenser. The boiler-feed pump, and condenser pump if used, are driven directly from the main engine.

Effect of Negative Advance with Single Eccentric—If the eccentric of a Corliss engine is placed less than 90 deg. ahead of the crank, what effect will it have in the operation of the engine? M. D.

By setting the eccentric less than 90 deg. ahead of the crank, the events of admission, release and compression will occur later in the stroke. The lead may be corrected by shortening the steam-valve rods to obtain admission when the engine is on a center. But the steam valves would be partly open—that is, would have negative lap—when the wristplate comes up to its central position. Cutoff then could occur through greater range than one-half stroke, because the stroke of the piston would begin before the wristplate reaches its central position for cutoff may occur any time before the wristplate swings farthest to one side or the other of the central position during one-quarter of a revolution of the eccentric, or approximately while the piston travel is equal to one-half the length of the stroke. If earlier release is obtained by giving negative lap to the exhaust valves, they will not be closed when the piston reaches the end of the stroke and the exhaust will be open simultaneous with admission to the same end of the cylinder. To avoid this difficulty a long-range cutoff Corliss engine is provided with a separate eccentric for operation of the exhaust valves.

Reconnection of Armature Winding—What will be the correct pitch of the coil leads on the commutator of a single-series wound armature having 180 coils in the winding and 180 segments in the commutator? The machine has 6 poles and operates at 550 r.p.m. on a 250-vole circuit. At present the armature is wound single-series and is giving considerable trouble by heating excessively and also sparking at the commutator. Is there any way that I can tell if the armature should be wound single, double- or triple-series? C. R. S.

If the armature has 180 coils it cannot be connected single-series since the number of coils must agree with the formula,

$$C = \frac{P}{2} \pm 1$$

Where C equals number of coils in the winding, P the number of poles and X an integer which equals the pitch of the leads on the commutator and is obtained by dividing the commutator segments by the pairs of poles, in this case, $180 \div 3 = 60$; that is segments 1 and 61. Then the number of coils $C = \frac{6}{2} \times 60 \pm 1 = 181$ or 179. There are 180 coils in the winding, and since only 179 or 181 can be connected single-series, there is only one thing to do; namely, leave one coil dead and use 179. This will also require the bridging together of two segments in the commutator, thus obtaining 179 segments.

On account of the speed and voltage of the machine, it is very probable that a single-series connection is correct for the armature. If a single-series connection is correct, and the machine was connected double-series, the speed would be double that of normal, and with a triple-series connection the speed would be three times normal. However, a triple-series winding would not be used on a 6-pole machine, since the same results can be obtained with a single-parallel winding and the latter would be free from all the complications of the former.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses This is necessary to guarantee the good faith of the communications.—Editor.]

Thrift in Coal*

By GEORGE OTIS SMITH†

COAL is the shortest word we have to express industrial power and domestic comfort. Even the rumor of a coal shortage simply demonstrates that this fuel is in reality the staff of life to the industrial world, and the temporary stoppage of any of the larger sources of supply threatens a nation-wide crisis. Shut down our coal mines, and the country becomes not only cold but idle and hungry.

The figures of our total coal resources, millions of millions of tons, or even the few hundred million tons of our annual output, are too large to be grasped, and it becomes necessary to express the facts in smaller quantities. Roughly speaking, 1,000 tons of coal is what a mine worker mines in a year—the measure of what he contributes to the world's work and well-being. This human measure of 1,000 tons also has the advantage of being easily visualized as a short train load (20 cars) of coal on its way to serve the varied needs of the consumer, and in our brief review of the subject we may well first note what are these needs—the principal uses of coal, among which this unit of 1,000 tons is divided. (See Fig. 1.) Broadly stated, the largest use of coal is in furnishing motive power and heat for our industries and public utilities, 350 tons out of every 1,000 tons mined going to the boiler house of factory, mill, shop, or power plant. But next to these seven carloads of coal distributed throughout the country are five cars, or 250 tons of coal, which the railroads need for their own use. The domestic demand for coal comes next, 165 tons out of each 1,000 tons of anthracite and bituminous coal being used in the homes of the land for heating and cooking. The coke ovens require nearly as much as the homes, or 130 tons; and the balance of our miner's contribution includes the coal for export and bunker use, 60 tons; the 35 tons of coal used in operating the coal mines themselves, which of course does not make up a part of our train load; and the 10 tons that goes to the gas works.

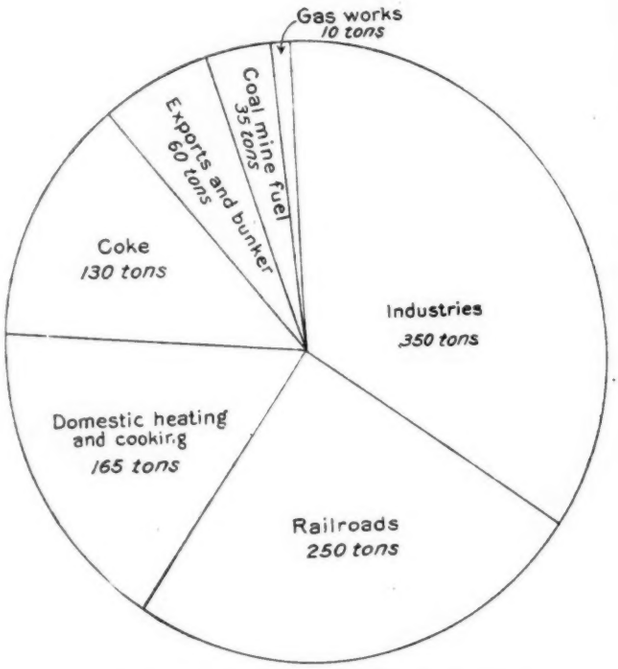


FIG. 1. WHAT BECOMES OF OUR COAL

Disposition of the miner's yearly output of 1,000 tons, including both anthracite and bituminous coal.

Even in this simple analysis of the uses of coal it would be difficult to establish any rigid scheme of priorities; we absolutely need coal for each of these uses, and this nation-wide dependence upon coal is so evident as to demand general attention to the subject of thrift in coal. Every citizen should do his part in making the best use of coal, but the responsibility of leadership in economy may with justice be placed upon the larger users.

The steel industry required in 1918 about 100,000,000 tons of coal, slightly more than two-thirds of it in the form of coke. So in dependence upon coal, this industry stands next to the railroads. At the bottom of the list of uses of coal, stated quantitatively, is blacksmithing, and the annual requirement of blacksmithing coal is less than a million tons. Contrast with the great steel plant, which consumes its 4 million tons of coal each year, the village smithy, which uses 50 pounds a day—and the question arises, Where is it of greater national concern that we begin to practice thrift in coal, at the little shop or at the big steel works? During the war the patriotic effort was made to save wheat and sugar in every home, however humble, and the aggregate results of such nation-wide thrift were most gratifying; yet with coal a different policy of initiating thrift seems warranted—the great industrial establishment or the superpower plant rather than the home is the place where saving will accomplish most.

We are on the threshold of fuel economy. Unprecedented high prices for coal have summoned American genius to the task of getting the full value out of the half billion tons of bituminous coal we burn each year; indeed, we have been too long content simply to burn coal rather than to use it. With coal at a dollar a ton the consumer was the profiteer, and profiteer-like he thought it paid him to disregard any claims except those of his own immediate gain. Now, the higher prices have opened our eyes to higher values in coal, and we begin to see the possibilities of profit in avoiding waste both in the mine and in the boiler room. We do not have to recognize the claims of posterity for coal conservation, for we can see money in it for our own generation — to mine the coal that we have been leaving underground, to utilize every possible heat unit in what we burn, and especially to recover everything of value that the coal contains. When we indorse Mr. Hoover's characterization of the bituminous coal industry as "the worst functioning industry in the country," it is with no spirit of unfriendly criticism. The simple fact must be faced that the story of coal is a story of waste, all the way from the face of the mine working to the smokestacks of the boiler plant—waste of a natural resource, waste of human endeavor, waste of capital, waste of transportation capacity, and waste of energy—and of none of these have we enough, much less any to spare.

It is customary to express our coal resources in terms of tons in the ground, but how inflated such an inventory becomes when we realize that of the ton of coal "in place," where Nature stored it for the use of man, the amount converted into mechanical energy, under the average practice of today, is only 76 pounds. The accompanying diagram, Fig. 2, exhibits the distribution of the losses thus indicated, in the responsibility for which mining engineer, mechanical engineer and consumer must all share. This general indictment of "average practice" makes the question of thrift in coal a national rather than an individual problem.

The proportion of coal we leave underground is a sad commentary on our appreciation of the value of coal, and the margin between high recovery, which may be stated at 95 per cent, and the average recovery of 70 per cent or less shows to what extent we are still wasting our coal at one place alone and where the world does not see the

*From an address before the American Iron and Steel Institute, New York City, Oct. 22, 1920.

†Director, United States Geological Survey, Washington, D. C.

waste. By increasing the average output of the mine worker, we have made a gain of 50 per cent in the last three decades, so that we are saving man power if not coal.

Not only is coal wasted in the mining, for no sooner does a ton reach the surface than 44 pounds of it is taken as toll for running the mine—indeed, in the anthracite mines, where often more water is raised than coal, the combined pumping, hoisting, and breaker operating cost expressed in coal has been stated as high as 200 pounds to the ton.

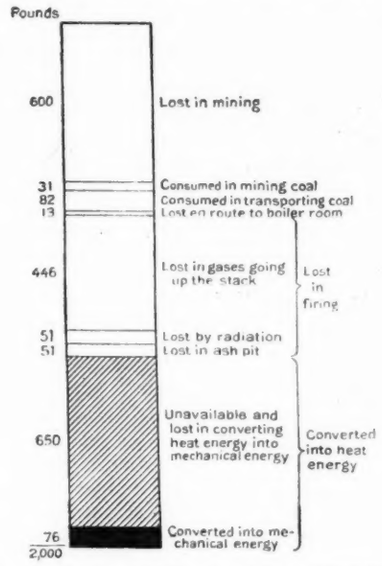


FIG. 2. EIGHT LOSSES IN COAL UTILIZATION
From data furnished largely by the Bureau of Mines, showing what becomes of a ton of coal under ordinary conditions.

But electrification of coal mines is gradually coming, with gratifying results in efficiency of operation and economy of fuel.

The consumer cannot evade his share of responsibility, because out of the 1,274 pounds of coal delivered at his boiler plant 548 pounds was lost in firing; he had been buying B.t.u.'s simply to throw away 40 per cent. Edwin Ludlow relates his observations at a large plant, where pride was taken in the fact that only the highest-grade coal was used, a standard of 15,000 B.t.u.'s being insisted on, but Mr. Ludlow called the attention of the company's executive officer to his boiler-room leaks, his steam results showing that he was obtaining only 11,000 B.t.u's from this high-grade coal. That coal user needed expert firemen more than chemists—better practice rather than more theory.

Another measure of coal waste in the generation of power, even where the conditions promoting efficiency are much more favorable, is afforded by the records of the public-utility plants of Massachusetts. During the month of June last the average coal consumption in all these plants was 2.29 pounds per kilowatt-hour, but at the largest plant of the largest company the average was 1.8 pounds—a saving in coal of more than 20 per cent, representing the difference between best practice and average practice.

How to save coal on a country-wide scale is the question. O. P. Hood, of the Bureau of Mines, has made the point that in a boiler plant construction, operation, and fuel are to a certain extent interchangeable. Skillful planning and careful operation can take the place of part of the coal; and on the other hand cheap coal has made possible careless firing of poorly constructed boilers without the wastefulness of the whole procedure being apparent on the books. Waste that can be seen only as a theoretical proposition does not appeal with the same force as waste that writes itself in red figures; and now that coal is no longer as cheap as dirt but has taken on the dignity that comes with high prices, we naturally begin to think of careful use. Just as we learned with foodstuffs during the war we are learning now that the higher value must be both given to coal and won from it. Thus the opportunity has arrived for the fuel engineer to teach us thrift in coal.

Still more striking is the evidence that can be brought forward to show the coal saving possible through the larger use of electricity as the agency in applying the energy in coal to the aid of human labor. Again it is proper to note in advance that the steel industry is already motor-driven as probably no other industry is—indeed, the motors used by this industry aggregate nearly one-third of the power of all the motors installed in the United States. Without allowing for the great possible saving of coal by the full development of our water power, combined and co-ordinated with steam power in large systems of electrical generation and distribution, the contrast between present average practice and best practice in power generation is so great as to strain our confidence in the simple figures of coal waste.

The statistics of fuel consumption show that the average steam plant, which is a small one (about 200 hp.), uses eight times as much coal as is necessary in the largest

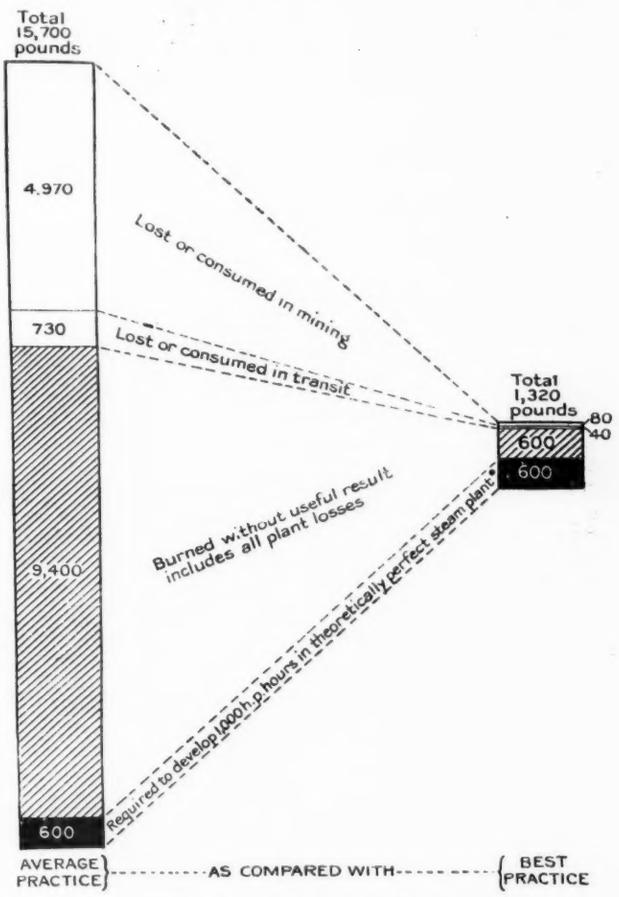


FIG. 3. AVERAGE AND BEST PRACTICE COMPARED
These losses in average practice are based on data from the Bureau of Mines and the Super-Power Survey, and are calculated as in Fig. 2, except that in this case allowance is made for the additional loss due to bad load factor.

central stations, where the profit payable to thrift is recognized — that is, assuming the same consumption as the average central station of the same size, our average-sized industrial steam plant would use 10 pounds per horsepower-hour. If to this initial saving of 7 pounds of coal out of 8 at the large electric power station are added the possible savings on the railroad and at the mine, the ratio between present average practice and present best practice becomes nearly 12 to 1. Even if this indictment of waste is discounted one-half, the power users of this country stand convicted of almost criminal negligence, for cheap power

and plenty of it provide the only way to retain America's industrial leadership. For this reason both labor and capital are vitally interested in the power supply.

This contrast between the wasteful and the economical use of our coal resources is set forth in Fig. 3, which like Fig. 2 was compiled by my associate, F. G. Tryon. Starting with the 600 pounds of coal that contains heat units equivalent to 1,000 horsepower-hours, we find that the big electric station, with its modern steam turbine equipment, uses along with the 600 pounds of coal another 600 pounds from which it derives no return. This seems wasteful enough, but the little steam plant, with its poor load factor as well as much less efficient equipment, losing heat units up the stack, in the ash pit, through the steam pipes, and in the engine, wastes 9,400 pounds of coal for every 600 pounds it really utilizes — nearly a 16 to 1 ratio in favor of the big plant. So too, if railroads and mines were electrified and only 5 per cent of the coal instead of 30 per cent were left underground, 120 pounds of coal would mine and bring to the big plant the coal burned in generating 1,000 horsepower-hours, instead of the 5,700 pounds now actually required in serving the average steam plant with the 5 tons of coal it burns to get the same product of useful energy. The total cost of 1,000 horsepower-hours in terms of coal resources is therefore about two-thirds of a ton with efficient use, and nearly eight tons under the average conditions of waste at the little plant.

It is cause for general satisfaction, then, that in the first half of 1920 we find the power output of the central stations of the country increased more than 16 per cent over that of the corresponding period last year, while the fuel used seems to have increased not over half that percentage. In these public-utility plants the trend is decidedly toward fuel economy.

Coke Making and Byproduct Ovens

The use of coal in America for making coke dates back some eighty years, but the operation of byproduct ovens covers only one-third of that period, and indeed only last year did the output of byproduct coke first equal that of beehive coke. The field is thus divided between the old and the new practice, but two advantages of the byproduct ovens over the beehive ovens alone show how much the full substitution will mean to our country. First, the yield of coke in the byproduct ovens compared with that in the beehive ovens is 23 to 25 per cent greater with the low-volatile coals and 7 to 8 per cent greater even with the high-volatile Pittsburgh coal; and second, the recovery of 7 to 15 gallons of tar, benzol, toluol, and other oils, 16 to 30 pounds of sulphate of ammonia, and the surplus gas constitutes a great resource by itself. The recent consolidation of five great chemical companies calls attention afresh to the value of these wasted constituents of coal, for not only will this consolidation go far in making America industrially independent in the matter of dyes and other coal-tar derivatives, but the new corporation, which is one of the largest units in American industry, is founded chiefly on the profitable utilization of coal smoke.

Already fuel economy has reached so high a mark in the largest steel plants that the present practice gives gratifying results. Take, for example, such a plant with an annual fuel consumption equivalent to perhaps 4½ million tons of coal, and we find there the best by-product coke practice with utilization of the by-product gas and tar for melting and heating throughout the plant; also the waste gases from the blast furnaces are used in gas engines to blow the furnaces and generate electricity to meet the extensive demand throughout the works both to operate cranes, machine shops, etc., and in motors to drive not only the smallest but also the largest of our rolling mills.

But to picture the extension of this thrift in the use of coal as planning on a national scale demands, we are forced to supply some conditions that are not yet realized. This use of coal first as a raw material and next only in part as a fuel means the extension of byproduct practice until in no home or public building or factory will we find raw coal burned, but in its place either coke or gas, the other products having first been extracted to furnish the fuel for our motor cars, the dyes for our clothes, the surface for our roads, and even the drugs for our aches and pains. Several new methods of carbonizing coal are now being developed with the purpose of increasing the yield of valuable oils and of obtaining coke residues better fitted for domestic use—all looking forward to this much more general use of coke.

Unwarranted Optimism as to Reserves

The fact that more than half of the world's coal reserves are believed to lie within the territory of the United States has led too many of us into unwarranted optimism. The captains of the great industries concentrated along the Atlantic seaboard will do well to think less of the millions of millions of tons of coal that are said to lie awaiting their need in various parts of this continent-wide country of ours, but rather to ask for details as to where this coal is and how available it is for the use of this and the next generation. The total tonnage involves strings of figures hard for us to comprehend, but the tonnage remaining in the great producing fields of the East is so limited as to compel us to foresee their exhaustion within periods of the same order of magnitude as those which executives figure as the expectancy of life for industrial enterprises.

For example, the Pittsburgh bed in western Pennsylvania was estimated forty years ago as good for thirty generations, but the rate of mining has so greatly increased that now we must measure the exhaustion of this largest bed in the Keystone State by the span of a single generation. This is not an exceptional illustration of the shortened life due to unexpected increase in drafts upon our coal resources, for in the Georges Creek field in Maryland this same bed, there called the "Big Vein," was believed forty years ago to have a life of at least 150 years, but today the field is regarded as almost worked out. Even if you turn to a less nearly exhausted field, such as the Pocahontas, the earlier optimistic calculations of an expectancy of life of four or five generations are now reduced to three or even two. The lesson is that no matter how carefully the tonnage estimate of the coal reserve is made, no one seems able to estimate the rate of increase in demand in this growing country of ours. Not yet do we show any signs of slowing down in our industrial progress.

Another fact to be set down is that the best and most accessible coal is mined first, and even now we are skimming the cream from our coal resources. The truth should be stated even more plainly—we are mining much of the best coal with such disregard of the thinner beds in the same fields that we may be justly accused not only of carelessly skimming off the cream, but of throwing away the skim milk beyond any possible hope of recovery. We must therefore figure on increasing costs in the future, due to greater depth and longer hauls to market. This is another reason for delaying the exhaustion of our eastern coal fields by making full use of the coal we are now mining.

What Boiler Scale Does

Approximately 500 persons are killed and 800 injured annually throughout the United States by boiler explosions. Most of these accidents are preventable.

Of 376,822 steam boilers examined by the Hartford Steam Boiler Inspection Co., 184,635 were found defective, 19,219 dangerous and 1,122 uninsurable. The chief defect was a preventable one—scale.

Adhering scale caused 42,877 defective boilers, loose scale or sediment 28,212. Of the former, 1,612, and of the latter, 1,593 were found dangerous. Internal corrosion was the second chief defect, 19,008 boilers being found defective and 793 dangerous. External corrosion caused 10,968 defective and 814 dangerous boilers.

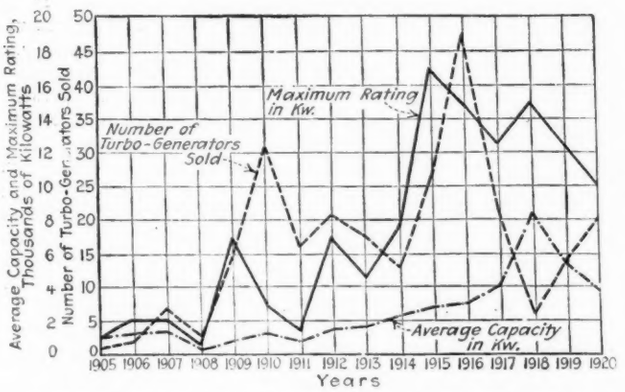
Scale is largely preventable; and so is corrosion. Scale and corrosion are different effects of very similar causes. Greater attention to boiler feed-water means safer, more efficient, longer-lived boilers, lower insurance rates and greater security.—*The International Steam Engineer.*

Power-Plant Equipment for Steel Mills*

The last five years of turbine development have been characterized by a rapidly increasing tendency toward the concentration of large capacities in single turbo-generators, by advances along the line of better economy and greater simplicity, by the use of higher steam pressures and superheat and by provision to obtain the full benefit of high vacuum.

From the curves in the figure it is seen that in 1905 the average capacity of turbo-generators installed in steel-mill power houses was about 1,000 kw., while in 1920 this has increased to an average of 4,000 kw. The maximum rating during 1905 was 1,000 kw., while today it seems to be in the neighborhood of 10,000 kw. The largest turbo-generator installed in steel mills is a machine rated at 20,000 kw. at unity power factor, at the plant of the Jones & Laughlin Steel Co. The average number of turbines sold in 1920 will be approximately twenty times that of fifteen years ago.

Although ten years ago the steel companies were buying low-pressure steam turbines to utilize exhaust steam from engines, the present-day tendency seems to be for larger


Average Capacity and Maximum Rating, Thousands of Kilowatts
Number of Turbo-Generators Sold
Maximum Rating in Kw.
Number of Turbo-Generators Sold
Average Capacity in Kw.
Years
1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920

TURBO-GENERATORS INSTALLED IN STEEL MILLS

high-pressure turbines. This selection of larger units is due to the almost unanimous opinion that the best practice is to have one or two central power plants to generate all the power and to equip all the apparatus in the plant with electric drive. This scheme is followed where new plants are installed, and the change from steam-engine units to electric units in old plants is taking place as rapidly as financial conditions will justify. It seems that it is only a matter of time until all plants become more or less completely electrified, at which time power houses of considerable capacity will be required and therefore specifications for turbines today should be made on this basis, which naturally results in the selection of units of comparatively large size to take advantage of the better economy obtained on large units.

Central-Station Power

During the war the rapid growth of many steel plants brought central-station power into prominence, but today it is a question whether this rapid growth will continue, owing to the rates charged by the central-station companies, troubles due to power failures and also to the fact that it is more economical to develop the waste heat available from blast furnaces, open hearths, etc.

The advantage of tying industrial plants to central-station lines or interconnecting various industrial plants has received considerable attention during the last five years. The Carnegie Steel Co. in the Pittsburgh district was the first to tie its power houses together and thereby was able to operate any one individual plant with less spare capacity and also to take advantage of the diversity factor of all the plants involved, which allows each one of them to operate at a more constant load with better economy. This system has been extended and now includes the National Tube Co.'s plant at McKeesport.

In addition to the foregoing the central stations that supply power to steel companies which do not operate their own generating equipment have been tying their power systems together so that the purchaser of power must now have circuit-breaker equipment to take care of the ultimate capacity of all the plants connected to the system instead of the individual power company contracted with. As systems are tied together, in order to be properly protected it is necessary for the steel companies to provide larger circuit-breaker equipment, use reactors and in some cases adopt the grounded-neutral system, as all these features tend to eliminate troubles that are otherwise not present on small generating systems. The large central-station companies have been forced to take these precautions, and now that the steel companies are installing systems which within a few years will be equal to the capacity of some of our present-day central stations they, too, will find it necessary to add these protective devices.

*Abstract from the Association of Iron and Steel Electrical Engineers' Electrical Development Committee's Report, presented at the fourteenth annual convention, held at Hotel Pennsylvania, New York City.

Testing Welds*

By S. W. Miller, M. E.

The question of testing welds is one that has been considered more or less since welding was known, but especially during the last five years. Its importance has now become very great. There have been many failures in the past, many of them not having been explained and some of them having been very expensive. As in all other developments, welding first received its principal impetus from the practical man. Of late, however, the tendency has been to investigate more carefully and more fully and by means not available to the ordinary welder. This means that scientists of all kinds have been called into consultation and that almost every conceivable method of test has been suggested in order to determine what methods and materials would make the best welds from a standpoint of security, service and cost.

The welding of steel is frequently considered as not being especially difficult, and it is also sometimes considered that steel is steel and that no different treatment is required in the case of different qualities and varieties of steel. This idea is much less common today than it was several years ago, but it is still too prevalent for the good of the art. It is not as well known as it should be that a comparatively small difference in the percentage of carbon in the material being welded makes a very great difference in the results of either a bend or tensile test. If the carbon is 0.12 per cent or less, the material is soft, ductile and yields readily to any strain that may be put on it. Such material is frequently used for tanks and, because of its ductility and comparative freedom from damage by heating, is admirably suited for welding. Structural steel, bar steel and boiler plate contain about 0.15 per cent to 0.25 per cent carbon and have a tensile strength of about 60,000 lb., while the soft low-carbon material has only about 52,000 to 55,000. Ship plate is required to have a tensile strength of from 58,000 to 68,000 lb. and in the heavier sections requires as high as 0.30 per cent carbon. It has been found by experience that the higher the carbon, the more difficult it is to get a satisfactory weld and the more danger there is of injuring the metal being welded. It is also evident that a weld made with a given welding rod or electrode can have only a given strength. If this strength is greater than that of the material being welded, the test piece will always break outside of the weld. If, on the other hand, the weld is weaker than the material being welded, the rupture will always take place in the weld. An oxyacetylene weld made with ordinary low-carbon welding wire will have a tensile strength of about 52,000 lb. This is stronger than soft tank steel and weaker than the other materials mentioned. It is possible to get with alloy steel rods of proper composition a tensile strength in an oxyacetylene weld of about 50,000 lb. Neither of these mate-

*Abstract from a paper read before the September meeting of the Chicago Section of the American Welding Society.

rials will weld boiler steel, boiler plate or ship plate, so that the rupture will occur outside the weld when the section of the weld is the same as the section of the piece, and in making tests of welded pieces, it is necessary to know accurately the character of the material being welded.

The method of test to be applied in any given case depends largely on the use to which the welded piece is to be put. If it is to be used in a pressure vessel, I believe that not only should a tensile test be made, but that an alternating stress test should be used because of the breathing of the tank due to changes of pressure. This latter test should also be applied where the weld is subjected to bending strain. There are no standards at present for weld tests, but it is advisable, wherever possible, to follow those of the A. S. T. M.

The best test, in my opinion, to determine quickly the general character of a weld, is to grind it off level with the surface of the pieces and clamp it on an anvil, with the center of the weld level with the top of the anvil, the bottom of the "V" toward the anvil so that the top of the weld is stretched when the projecting end is struck with a sledge. The blow should not be too heavy, and the number of blows and angle to which the piece bends before cracking are quite a good index of the value of the weld. It is true in this test, as in the tensile tests, that the quality of the material being welded has a great influence on the results. Stiff material throws more of the strain into the weld, while soft ductile material will itself take considerable of the bend. In the case of defective welds—that is, those not fused along the "V" or which contain slag or other inclusions—this test will at once develop the defects. If a welded piece were to be used in a place where it might become red hot such as, for instance, in a locomotive fire-box crown sheet, it would be entirely proper to test the welds at a good red heat by clamping them in a heavy vise or on an anvil with the center of the weld about half an inch from the edge of the vise or above the face of the anvil, heating them to a bright orange with the torch and then bending them as before as with a sledge.

If such welds are made in ½ x 2-in. bar steel, a 90-deg. single "V" being used, and they bend to a right angle cold without cracking on the outside, a welder may feel well satisfied with his work.

Testing Rails for Hidden Defects

There has recently been developed a method for testing rails for hidden defects which was devised by A. M. Waring. It consists of deeply etching a polished surface of the material under test. For instance, a section of a weld might be cut out with a hacksaw, machined or filed to a true surface, and polished on various grades of emery paper, ending up with 00 Manning. It is then placed in a warm solution of 25 per cent hydrochloric acid and water for from one-half to an hour. The acid will eat away the defects, making the edges of the material at them taper, so that rather large grooves and pits will be visible where the defects prior to the etching would be only microscopic. The etching test I consider to be of the greatest value in ordinary shop practice where it is desired to find out rapidly and quite accurately the quality of the work done by the different welders.

These rough tests, while satisfactory for determining the general quality of the work, do not answer as a basis for design, and more refined tests must be used as before referred to. I believe that the most important of these are the tensile and alternating-stress tests. The tensile test can be made in any shop provided with the usual tensile testing machine. The alternating-stress test is not as yet standardized even for unwelded material. I am inclined to believe that the machine devised by the Quasi-Arc Company is of considerable value, although it does not give absolute results; that is, it does not give the amount of fiber stress to which the piece is subjected.

A great deal may be learned from the appearance of a weld. It is difficult to describe the appearance of good welds, but after they have been seen a number of times, an inspector can readily say whether the operator knows what he is doing. In gas welding, I would not accept a ripple weld in heavy material nor one which was narrower than about 2½ times the thickness of the sheet, because I have never seen a weld having these appearances that was properly made. The appearance in a gas weld of porosities on top indicates that the metal has been overheated, and the same thing is true in an electric weld. Inasmuch as I believe that the serious defects in welds are caused by oxides, it would appear wise in the case of gas welding to use no larger top than is necessary to produce thorough fusion. This means that the catalog speeds of welding are impossible if good welds are desired. The same thing is true of electric welds. The reason is that at the high temperatures of the steel caused by too large a tip or too heavy a current, the metal becomes overheated, and in that condition combines more readily with the oxygen of the air or with any excess oxygen in the torch flame, and produces oxides which are readily dissolved by the melted metal. As the metal cools down, these oxides are rejected in large part and pass to the grain boundaries, as do other impurities, so that it is perfectly natural that material that has been seriously overheated should be more brittle and weaker than the material that has been properly melted. In conclusion, I have found in a number of cases that very great improvements in the quality of the work were made by using regularly the bending test already described and by carefully instructing the welders until they were able to make welds that would meet this test with unfailing regularity.

The Mechanical Engineer the Heir of All the Ages

On Friday evening, Oct. 22, at the Morrison Hotel, the Chicago section of the American Society of Mechanical Engineers held its first dinner meeting of the season. The new chairman, H. S. Philbrick, professor of mechanical engineering at Northwestern University, was in the chair. He spoke of the spring meeting of the society which is to be held in Chicago at the Congress Hotel, from May 23 to 26. A request was made for suggestions on excursions, topics for discussion, and in fact any suggestion that might help make this meeting as great a success as the previous gathering of the same society sixteen years ago. Attention was called also to the next meeting of the Chicago section, at which Dr. George Otis Smith, of the U. S. Geological Survey, will talk on "Industry's Supply of Energy." Historical reminiscences of the society will be a feature of the meeting in commemoration of its founding forty years ago.

Mr. Finley's Address

W. H. Finley, president of the Chicago & Northwestern R.R., who was the speaker of the evening, took as his subject, "The Mechanical Engineer." Speaking from the railway viewpoint, he had always felt that the mechanical engineer did not get the appreciation that was due him, although in this regard times were changing. In the early days the great majority of engineers employed were of foreign extraction, with an odd American here and there. The technical schools of the country are now turning out engineering graduates in shoals, and many of them develop into excellent engineers.

In the early days of the railroad the engineer assumed knowledge on all kinds of engineering work and the officials expected him to do it. They were now beginning to realize that it was desirable to have experts in the different branches of engineering, although it was his feeling that even yet they had not employed the mechanical engineer enough. There were so many places where his knowledge would be of great benefit, such as in the conservation of fuel, the heaviest of railway expenses, development of the locomotive stoker, superheater and other mechanical appliances tending toward efficiency. The comparatively small oil supply and the limited amount of energy available from water left coal as the leading fuel. Devising efficient methods of burning this fuel and of conserving it were functions of the mechanical engineer, but this was only a

small part of his duty. The mechanical era was just opening up and remarkable developments were to be expected. Even on the farm the mechanical appliances in use today were marvelous when compared to the equipment used by the last generation. The engineer must take his part in directing and guiding labor and in the elimination of the labor troubles so common in these days. To do this effectively he must know human nature, make himself better known to the public, take a greater interest in public affairs and with his knowledge back of him assume his proper sphere in the world's work. The mechanical engineer was the heir of all the ages. He was now passing the civil engineer as he had a bigger, broader field than any other branch of engineering.

In the speaker's opinion every branch of engineering needed an engineering society, and the discussion here should be limited largely to technical matters relating directly to the field. Only in this way would rapid development be assured. He did not favor the turmoil of the present day and the branching out into fields foreign to the profession, or at least, verging on the distant horizon. Civil affairs and subjects foreign to the field should not be mixed with the technical side of engineering.

Discussion

Colonel Henry A. Allen agreed that the engineer should take his place in public life, but said that he must be careful how he did it. The engineer was accustomed to systematic analyses from cause to effect so that he should be more logical than most men—one of the necessary qualifications for a leader. He believed that the time was not far distant when the steam engine would resume its place at the top of the mechanical field and be more efficient than any other type of prime mover. The theory of harmonics might play an important part in this development.

W. L. Abbot referred to the stampede of professors and technical instructors into commercial life, due to the higher salaries obtainable and the miserable pittance now paid them. At the same time there was a great increase in the number of technical students, and with the shortage of instructors it was necessary to group them into classes double the size that it was formerly recommended one professor should handle. With the teaching profession going into commercial life and the pupils per instructor so greatly increased the graduate engineers were not so good as they should be nor so good as they were previous to the war. In these days the cost to the student was comparatively high and a college course took the best four years of his life. Consequently, he was entitled to the best instruction obtainable. It was his earnest desire to see salaries in the teaching profession so increased as to encourage the best engineers to enter the field of teaching and to retain the best of those that were left.

Engineering Council Meets in Chicago

On Oct. 21 the Engineering Council spent the day in Chicago at the rooms of the Western Society of Engineers discussing the various matters which this body has had under consideration. There were progress reports from committees and incidental mention of other matters, but the discussion turned chiefly to the Patent Office situation, the proposed Department of Public Works and to the registration of architects, engineers and land surveyors. It was one of the usual meetings of the council held in Chicago to give Western members a better opportunity to attend. J. Parke Channing was chairman of the gathering.

On the classification and compensation of engineers the council had done some good work. It only remained to give publicity to the subject as well as to address communications to Government, state and civil bodies. A full report containing a complete review of the work of the committee as a whole for the past year was to be presented at the next meeting.

While the Water Conservation Committee had been extremely active, getting advice and data from the best engineers in the country on the regulation of water power, it was not ready to report at the present meeting. It was the general consensus of opinion that the council should favor this committee's making a report to the Water Power Commission, giving only general principles and leaving the details to be worked out by engineers retained by the commission.

Closer co-operation between civil and military engineers was proposed, and it was suggested that letters from the Military Affairs Committee be addressed to the heads of the several technical services of the Government.

A typical registration law for architects, engineers and land surveyors was finally approved by the council as remodeled by the License Committee. Before final adoption it is to be referred to the architects for their approval, as the desirability of co-operation between these two professions was recognized. While the council was not particularly in favor of registration it was realized that the progressive tendency of the day called for some such action. In fact, eleven states had already passed registration bills more or less radical in their requirements and differing one from the other. It was considered of utmost importance to have a model bill ready that could be sent out as a guide wherever legislation on the subject was pending. Such procedure would tend to insure uniformity and eradicate undesirable features. As it reads at present, the bill does not prevent anyone from practicing engineering or architecture provided he does not call himself an engineer or architect and does not use the word "registered," the latter term indicating that his qualifications had been passed upon by the proper official body.

Department of Public Works

M. O. Leighton made a strong appeal in behalf of the national Department of Public Works. While the campaign for the organization of the Government's engineering forces into one department had been successful beyond expectation engineers had lately shown apathy, and unless they rallied and gave strong moral rather than monetary support others outside of engineering would acquire the credit for the success of the first great engineering movement. The question was raised whether civil or military engineers should control the public works of the country. It was stated that the die would be cast at the next meeting of Congress so that if any action were to be taken promptness was a necessity. More of this will be given in detail on another page of this issue. The council decided to send out letters to all engineering societies in the hope of rallying engineers into a renewal of their enthusiasm for the movement.

Patent Office Reorganization

The proposed bill for the reorganization of the Patent Office had met with no obstacle except that the Senate had reduced the force in the department, although in the bill the fees had been increased to cover an addition to the force and increases in salaries. This additional help was badly needed in the Patent Office as the volume of work was very great, and the department was so far behind that it had almost ceased to function. It was considered the duty of the council to have the bill restored to its original form, and to this end all engineers will be requested to write their respective representatives.

It was agreed that the council should give its support to the placing of engineers in the public health service on the same footing as medical officers. There was also favorable expression toward giving all assistance possible to the Federal Power Commission by urging Congress to make the $476,000 appropriation requested as well as appropriations for research work, especially for the Bureau of Standards. It was agreed, however, that these matters might better be left to the successor of the council.

For engineer of the new shipping board the council suggested the following three men as possible candidates: W. H. Adams, of Detroit; Prof. Henry E. Riggs, of the University of Michigan, and Admiral H. H. Russo, of Washington. The first two seemed to be favored as they came from the Great Lakes District. All steps for transfer of the work and termination of the existence of Engineering Council were left to the next meeting, which will be held on Nov. 17 in Washington, D. C.

Black Coal Versus White Coal*

"The attention of the nation is now more than ever before directed to the need for coal conservation, cheaper power and development of our great unused water power assets." With these words Hon. Alexander T. Vogelsang opened his address before the convention of the Water Power League at Washington. He brought out clearly the acuteness of our national need for coal conservation and discussed in considerable detail the methods by which this problem must eventually be solved.

In the first place the speaker pointed out that the price of bituminous coal has increased about 175 per cent in the last seven years, and that the increase of population, of industrial activity, of necessity for food distribution, together with the constantly contracting ability of railways to meet the situation, causes a condition that calls most stridently for relief. This condition, however, is not due so much to lack of supply, as it is to improvident and inefficient use, the great distance between mines and industrial centers, and the consequent burdensome haulage of coal to the exclusion of other and more valuable merchandise and commodities.

In regard to the inefficient use of coal strong arguments were brought up to support the speaker's contention that the ordinary steam locomotive is decidedly wasteful. He said that it had been shown that one electric locomotive is as efficient as four steam engines. On the Butte, Anaconda & Pacific Ry. seventeen electric engines do the work of twenty-eight Mastodon-type locomotives. The practicability of this use, its economy and its efficiency have been conclusively demonstrated by the Chicago, Milwaukee & St. Paul R.R., in its mountain divisions using hydro power, and the New York, New Haven & Hartford using steam-generated energy. This, however, is but one of the many ways in which coal can be saved.

It is expected that the super-power survey of the North Atlantic industrial district, now in progress, will show that 30,000,000 tons of coal may be annually saved in that district alone; and on this basis it is fair to assume that country-wide efficiency in coal consumption will save at least 150,000,000 tons annually. It is estimated that this would liberate nearly 20,000 railroad cars for other uses. More efficient methods of burning coal, therefore, are needed not only to save the coal itself, but to relieve railroad congestion.

Our Water-Power Resources Distant from Population Centers

The railroad problem, however, is complicated by a condition peculiar to this country. While in Europe the water-power, or "white coal" resources are generally found lying close to great population centers, in our country just the opposite holds true. Seventy per cent of our "white coal" is located in the semi-arid West, far away from our population centers, and therefore far from the habitation of our labor supply. For instance, the State of Wyoming, with twenty times the area of Connecticut, ten times the water-power resources and enormous coal and gas reserves, has only 11 per cent of Connecticut's population and produces only 7 per cent as much energy in its public-utility plants. Wyoming has everything in the way of power resources and raw materials, but she has not the population necessary to large manufacturing enterprises. The question then is, Will the industrial centers be drawn by economic necessity to the source of power or will the haulage of raw material for power and manufacture continue indefinitely? The speaker expressed the opinion "that the pull of energy sources must prevail in the end." This, however, he regarded as rather fortunate than otherwise; for the West, which contains 70 per cent of our water-power resources, is the healthiest part of the country and, when present reclamation projects are completed, will have about 3,000,000 acres under cultivation. This land should support, directly and indirectly, a population of nearly 1,000,000. It is more than half expected, however, that 40,000,000 acres will be irrigated ultimately, and this should be enough to support upward of 13,000,000 people. The semi-arid West will in time be capable of supporting a population great enough to utilize its resources directly.

This western movement will make feasible and necessary the utilization of our "white coal" reserves. It will remove the chief obstacle to such development; namely, distance from the point of application, by bringing factories to the very source of power. Aside from the power that such factories will need, however, will be the ever-increasing use of it to run agricultural machinery of all kinds. Electric energy may be and is being profitably applied to almost every farm operation, from the plow of the field to the sewing machine in the household. A shining example of what can be done in this respect is in California, where the production of rice has been made possible through pumping by electric power. The value of the California rice crop of 1919 was $27,000,000, yet the cultivation of that cereal only began commercially in 1912. In California the farmer uses more electric energy than in all other states combined, and this is practically exclusively water-generated.

All this goes to show that not only the conservation of coal, but the progress of agriculture, of industry in general even, depends upon the utilization of our water-power resources.

What Foreign Nations Are Doing

Foreign nations are coming to a realization of these facts faster, apparently, than are we. One of the large American companies engaged in the manufacture of water-power machinery states that it is receiving three foreign inquiries for such machinery to one received from the United States, and that if orders shall be placed in proportion, its shops will be filled with foreign instead of domestic orders. It thus behooves us to be up and doing in this direction. In most foreign countries development will be undertaken by the government itself, but in Spain and perhaps other countries liberal concessions are offered to private enterprise. Some initial help should be given development projects of this kind, for they are generally designed to provide much more energy than is needed at the time they are built and consequently do not earn much at first. The harnessing of flowing water is very expensive. The initial outlay is very great, but maintenance and operation are comparatively low, and falling water does not go on strike nor cease operations for human reasons. The Government owes it to itself to provide aid in this matter, for the industrial primacy of a nation depends upon the extent and cost of its mechanical power, upon the economical production and transportation of manufactured goods and high value commodities.

New sources of power are now under very active development in California, where the demand still far outruns the supply. The Pitt River system, having a producing capacity of about 500,000 hp., is under present and vigorous attack, and it is safe to assume that in five years a large percentage of its potential will be flowing over the wires.

The Feather River system, of at least equal capacity, is likewise receiving intensive treatment and will shortly pour increased streams of power into the eager market.

Similar enterprise is manifest southerly in the Sierra region, so that we may expect in a few years to see the continuous hydro power of California doubled.

Fullest development of all of these sources will involve more or less use of public lands.

Effect of New Water-Power Law

The new water-power law has cleared the atmosphere of much fluff and dust put in circulation by many well-meaning though impractical folks, and it is a fair chart for enterprise and investment wherein the public interest has been well protected. The right of the states to regulate rates to consumers is recognized, and such regulation by carefully selected commissions has thus far had general public commendation. Indeed, with public control of financing, extension, and rates to yield only reasonable return upon cost, it would seem that in this day there can be but small cause for complaint.

*Abstract of an address made by Hon. Alexander T. Vogelsang, First Assistant Secretary of the Interior, at the National Convention of the Water Power League of America, Washington, D. C., Oct. 7, 1920.

Unfortunately, detailed information of Alaskan water powers, which are known to be extensive, is very meager owing to lack of an appropriation for making investigation. It is hoped that Congress may immediately provide plans for a proper water-power survey in this land of large opportunity.

In closing his address, the speaker said:

No greater field for true conservation is open to the people of the United States than that of fuel preservation, and water-power development is its greatest possible conservator.

Let me conclude by expressing my full and free accord with the unselfish objects and purposes of the Water Power League of America. I am sure it will prove an invaluable aid and auxiliary to the Water Power Commission.

Perhaps its greatest usefulness may be found in the task of selling to the American public the conviction that cheaper power production is a national need, and selling that conviction in words and phrases devoid of technical terms and professional jargon so that all who hear may understand. This calls for hammering and rehammering upon the subject until the man in the street shall know as well as the expert that the use of falling water is the greatest and most important item in all the gamut of conservation.

The Need of a National Department of Public Works

Speaking before Engineering Council at the Chicago meeting of Oct. 21, M. O. Leighton, of the National Service Department, presented a strong argument in favor of the proposed plan for a National Department of Public Works. He mentioned two outstanding facts which evidently were not anticipated when the public-works movement took shape in Chicago in April, 1919. The first is that the engineers of the country in good faith started something which they do not seem inclined to finish. The second is that the scope of the movement and its ramifications extend beyond all limits written or spoken at the time.

No doubt the enthusiasm of many engineers has been cooled, and in some cases their active opposition has been brought about by the skillful campaign carried on by members of the Corps of Engineers, U. S. Army. No complaint is made of the activities of the army engineers, as their opposition to a public-works department was expected, and they have done only the very obvious things that civil engineers would have done if the situation were reversed. At any rate many of the civilian engineers counted on for support have been won over to the cause of the army engineers.

Efforts are now being made, however, to line up support behind the measure. Some weeks ago there was a meeting in New York City, attended by John T. Pratt, the head of the National Budget Committee; Herbert Hoover; Henry L. Stimpson, former Secretary of War; Paul Warburg and Major C. T. Chenery, at which matters of Government reorganization were discussed, and particularly the need for and the possibility of amalgamating all reorganization efforts under a commonly accepted and supported program. It was brought out that if the many organizations which are working for a National Department of Public Works conduct campaigns separately, each for its own particular project, the confusion created in Congress will probably result in no legislation; that is, each organization, while being unable to achieve its own ambitions, will, as a consequence of its activity, defeat the ambitions of every other. It was therefore decided to call a meeting of delegates from the several organizations advocating reform in the Government departments, for the purpose of organizing a Federal Reorganization Council, which would be the common body through which an accepted program would be carried forward.

These delegates met in New York on Oct. 14, at which time the nearly completed report of the National Committee on Governmental Economy was presented. That program provided for a general rearrangement of Government activities along functional lines, including the creation of a Department of Public Works by a reorganization of the present Interior Department, and an additional department to be called the Department of Education and Health, into which would be drawn such welfare activities as war-risk insurance, vocation and rehabilitation, pensions, etc. After discussion the idea of a National Council was tentatively adopted by the delegates with an agreement to report back to their several organizations for the purpose of securing adoption of the plan for a reorganization council and the appointment of delegates thereto. The meeting for final organization will take place on or about Nov. 15. The prospective field of such a council is not limited to the mere reorganization of Federal activities. It should, if properly conducted, become the authoritative unofficial body to engage in the work which will eventually lead to a distinct separation of the political features of our Government system from the conduct of departmental business.

When Congress meets in December the question will in all probability be settled for some time to come, so that the time is short and whatever action is to be taken should be commenced without delay. Mr. Leighton pointed out that although the principle of a Department of Public Works is thoroughly settled in the minds of the public and of a majority of the members of Congress, the important question remaining is the kind of department that we shall have. Shall it be civil or military? Shall the corps of military engineers be in command of all the Government's public-works functions, to the perpetual subordination of the civilian engineer; or shall they constitute, as was originally intended, a military arm of the Government and be given their training and experience by temporary assignment to positions in the civil work?

The civilian engineers of the country must decide, and if they are defeated in the forthcoming contest the fact will, in the opinion of the speaker, be an evidence that the military engineers deserve their success, for it will show that whatever may be their engineering qualifications and however severely their ideals may depart from those which are supposed to constitute the cornerstone of democracy, these men do, nevertheless, possess an essential characteristic which the great body of civilian engineers does not; namely, that they know men and are overvigilant in the exercise of their knowledge.

Federal Trade Commission Makes Recommendation on the Oil Situation

According to The American Petroleum Institute, the Federal Trade Commission has presented a report to Congress in which it makes recommendations to the effect that:

1. Those engaged in the oil industry in this country should be encouraged with all proper diplomatic support to develop production in foreign countries which have oil resources, in order to conserve our own supply.

2. In view of the excess of present consumption over production from domestic sources and increase in exports in spite of the deficiency, it might be advisable to restrict the exportation of domestic crude oil and its products.

3. Wasteful methods in drilling for oil should be studied with a view to discovering what remedies may be possible through state legislation or otherwise.

4. Appropriations should be made for a study of more economical methods of utilization, the possibilities of oil shale, and the availability of substitutes.

5. Information regarding changes in industrial and commercial conditions in the oil trade should be currently collected and reported for the use of Congress, the public and the industries.

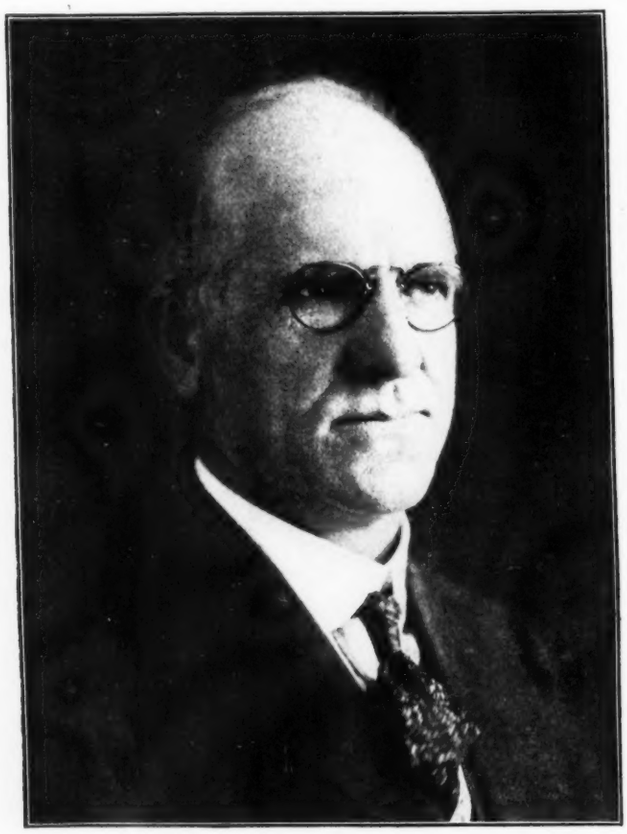
The United States Commerce Report for Oct. 15 contains an extended discussion of petroleum possibilities in Colombia. According to this report, "The Republic of Colombia is looked upon by prominent geologists as a promising field for the exploitation of petroleum resources. The world demand for petroleum and its products, the favorable reports of geologists, and the actual commercial production from several wells should prove an incentive to the development of the petroleum resources of Colombia."

Professor Allen Dies Suddenly

Professor John R. Allen, director of the Bureau of Research of the American Society of Heating and Ventilating Engineers, died suddenly on Oct. 26 in Pittsburgh.

His loss is a serious one to the engineering profession as well as to his friends; he has long specialized in the heating and ventilating field, and is responsible for a great part of the progress which has been made in this department of engineering activity in the last few years. His last important work along this line was in connection with the ventilating problems of the New York-New Jersey vehicular tunnel; he was consulting engineer on this work, and his comprehensive knowledge of the subject was of the greatest value in solving the difficult problems encountered.

Professor Allen was born July 23, 1869, in Milwaukee. After his graduation from high school, he entered the University of Michigan. He was graduated in 1892 with the degree of B. S. and was given his master's degree in 1896.



JOHN R. ALLEN.

His first position was with the L. K. Comstock Construction Co., where he remained for two years. At the end of this time he was appointed as instructor in the mechanical engineering department of the University of Michigan. His capabilities were recognized here, and by the time he left in 1911, he had become professor of mechanical engineering. His resignation was to enable him to organize Robert College, Constantinople, in which he was dean of the engineering department until 1913. He then returned to the University of Michigan as head of the mechanical engineering department.

In 1917 he again left the University of Michigan to become dean of the College of Engineering and Architecture, University of Minnesota. In 1919 he became director of the Bureau of Research of the American Society of Heating and Ventilating Engineers, in which he did some of his best work.

Professor Allen was active in a number of national engineering societies and was past president of the American Society of Heating and Ventilating Engineers, Michigan Engineering Society and the Michigan Chapter of the American Society of Heating and Ventilating Engineers. He was the president of the Minnesota Chapter of the American Society of Heating and Ventilating Engineers. In addition to these offices which Professor Allen held, he was an honorary member of the National District Heating Association, and a member of the British Institute of Heating and Ventilating Engineers, of the American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education and of the honorary societies, Tau Beta Phi and Sigma Psi.

Coal Operators Becoming Uneasy

Approximately one thousand soft-coal operators met in Cleveland on Oct. 26 to consider Attorney General Palmer's telegraphed request that steps be taken to eliminate exorbitant prices. This telegram, which was addressed to Colonel D. B. Wentz, president of the National Coal Association, was as follows:

I am informed that you have called a meeting of operators of bituminous-coal mines throughout the country at Cleveland for the purpose of complying with my recent suggestion that the operators should reduce prevailing unreasonable high prices for bituminous coal and thus lessen the number of prosecutions to be instituted by the Department of Justice for violations of the Lever Act in charging unreasonably high prices. If the operators limit themselves at that meeting to discussing prices with the sole purpose of preventing unreasonably high prices and without any attempt directly or indirectly to fix prices, I would consider such action as an effort to comply with the Lever law. It would be particularly helpful to this department if in pursuance of the general purpose to reduce prices the operators could arrange for reports to me voluntarily made to our district attorneys in cases where any operators continue to charge unjust and unreasonable prices. You will understand, of course, that I assume there will be no effort directly or indirectly to hold prices up or to make them uniform for any of the producing or consuming regions, either by the operators at the Cleveland meeting or by any of their committees or representatives.

A committee appointed to consider this matter reported the following resolution:

Whereas, An abnormal condition for some time past has existed in the bituminous-coal industry of this country, due to inadequate transportation facilities, labor difficulties and shortage and other causes beyond the control of the bituminous coal operators of the country; and,

Whereas, The Attorney General has requested the bituminous-coal operators of the country to co-operate with the Department of Justice in bringing about the elimination of unreasonably high prices for coal where such exist; and

Whereas, It is the sense of the bituminous-coal operators of the country that unreasonably high prices and unwise practices, where such exist in the industry be eliminated;

Therefore, Be it resolved that the bituminous-coal operators of the country refuse to ask or receive unreasonably high prices for bituminous coal, and further that all unwise practices in the industry, where any such exist, be condemned and eliminated; and

Be it further resolved that it be recommended to each bituminous-coal district in the United States that it immediately establish a committee in its district, and that such committee so established use every effort to co-operate fully with the Department of Justice and the United States Attorney in such districts to bring about an elimination of unreasonably high prices and unwise practices, where such exist, in order that the purpose and the object sought by the Attorney General throughout the whole country may be accomplished.

This resolution was unanimously adopted and was then forwarded to Mr. Palmer, together with a communication from Colonel Wentz, the chairman of the committee. Colonel Wentz notified Mr. Palmer of the passage of the resolution, and added:

Operators from some of the districts are already holding meetings in Cleveland preparatory to arranging co-operation with your representatives in their respective districts, and other meetings between your representatives and operators will be held promptly throughout the several producing districts of the country.

New Publications

THE PRACTICE OF LUBRICATION. By T. C. Thompsen, B. Sc., M. I. Mech. E. Published by McGraw-Hill Book Co., Inc., New York. Cloth; 602 pages; 227 illustrations. Price $5.

This volume covers the lubrication problems occurring with all types of machinery and is probably the most complete treatment of this subject that has yet been published. Usually, a volume on an engineering subject must meet the needs of either the technical or the practical man; Mr. Thomsen has happily been able to collect and present material that is of vital importance to both classes of engineers. Regardless of the particular class of machinery under his supervision, every engineer will find here much information for his guidance in proper selection or use of lubricants. It is a volume that fills a decided need and should meet a welcome reception from the engineering public.

Personals

Gordon Fox is to take up work as electrical engineer for Freyn & Brassert Co., consulting engineers, at 645 Peoples Gas Building, Chicago, Ill.

Robert Craig, chief engineer of the American Sales Book Co., Niagara Falls, N. Y., has resigned his position and will make a visit to Scotland. Upon his return to this country he will locate in California.

W. D. Mann, formerly with the American Incandescent Heat Co., is now combustion engineer in the engineering department of the Petroleum Heat and Power Co., Boston, Mass., formerly Fess Rotary Oil Burner, Inc.

Thomas Durban, for years identified with the selling department of the Erie City Iron Works and first chairman of the Administrative Council of the Uniform Boiler-Law Society, has accepted a position with the Erie Forge and Steel Co.

Charles M. Reed has recently accepted the position of power engineer for the Portsmouth Cotton Oil Refining Corporation, Portsmouth, Va. He was formerly assistant to the steam engineer, American Sheet and Tin Plate Co., Pittsburgh, Pa.

Kenneth Watts, who for the last seven years has been in charge of the gasoline plants and producing properties of the Oklahoma Petroleum and Gasoline Co., of Tulsa, Okla., is to take charge of the operation of a large oil company in South America.

Society Affairs

The Cleveland Section of the Association of Iron and Steel Electrical Engineers will meet Nov. 8. Gordon Gage, of the American Rolling Mill Co., will discuss "Slip Regulators vs. Notchbacks." All Cleveland Section meetings will be held at the Electric League Club Rooms, Hotel Statler.

The American Society of Mechanical Engineers is to celebrate its twentieth anniversary on Nov. 5. For the first time since the special meeting of the society, held at the Panama Pacific Exposition in San Francisco, the president has called a special meeting of the society to be held on Nov. 5 in the Auditorium of the Engineering Societies Building in New York City. At the same time meetings are to be held in cities all over the country, and these will be considered supplementary to and part of the gathering in New York. The latest report indicates that meetings are to be held as follows: Connecticut, at New Haven; Waterbury Branch, in the Chase Company's office building, Waterbury, Conn.; Mid-Continent, Chamber of Commerce Rooms, Tulsa, Okla; Philadelphia, Smoker at the Hotel Adelphia; Pittsburgh, at the Chatham Hotel; Boston; Minnesota, at St. Paul Hotel, dinner preceding meeting; Washington State, at Faculty Club, University of Washington; Hartford Branch, at City Club, Hartford, Conn.; Providence, in Engineering Society Rooms; Atlanta; Columbus; Indianapolis; and Chicago, at the Morrison Hotel. The Baltimore Section will meet Nov. 4 instead of 5 at the Engineers' Club.

Business Items

C. W. Hunt Engineering Corp. has been organized with offices at 143 Liberty St., New York City, for the purpose of handling all sales entailing engineering in connection with the Hunt products and all engineering services previously performed by the C. W. Hunt Co., Inc.

An Industrial Information Bureau, which should be of interest to those who do, or desire to do, business in China, is to be established in February, 1921, by the Government Institute of Technology at Shanghai, China. This school is under Chinese government support and prepares engineers and railway administration men with a technical education equivalent to that of any engineering school. These men often are located away from the port cities and when they desire information regarding equipment find it difficult to obtain. To meet this need the school is about to open this bureau. Manufacturers who are interested are invited to send catalogs, specifications, designing data, approximate costs, samples or models. In case samples are sent an attempt will be made to place same in running order. No sales will be made or attempted. Impartial information alone will be offered. A member of the faculty is now in America on leave and he will be glad to communicate further with any who desire information regarding the China field. Address H. A. Vanderbeek, 5 Cammann Place, Somerville, N. J., until December, 1920, and Box 951, U. S. P. O. Shanghai, China, after that date.

Trade Catalogs

The Godfrey Conveyor Co., Elkhart, Indiana, has ready for distribution a new catalog of its coal carrying system. This apparatus is designed to unload coal to storage or bunkers, to reclaim it from storage to bunkers and to handle ashes, sand, crushed rock, gravel and similar materials.

New Construction

PROPOSED WORK

Mass., Springfield—The H. R. Huntting Co., 21 Besse Pl., is in the market for a 1 or 2 hp., 220 volt, 800 r.p.m. d.c. motor.

R. I., Providence—The Pub. Bldg. Dept. will soon award the contract for a 3 story school including a steam heating system on Jastion Ave.

Conn., Hartford—The Amer. Sumatra Tobacco Co., Burnside Ave., plans to build a 6 story office building etc. on Commerce, Grove and Mechanic Sts. About $500,000.

Conn., Hartford—The Bushnell Memorial Association, 108 Gillett St., plans to build a 1 and 2 story auditorium on Trinity St. and Capitol Ave. About $500,000. A. R. Hillyer, Pres.

Conn., Winsted—J. Hannon, 3 Cherry St., is in the market for a 10 or 12 hp., steam boiler, with 80 lb. pressure. (Used, in good condition.)

N. Y., Brooklyn—The Bd. Educ., 500 Park Ave., New York City received bids for the installation of a heating and ventilation system, etc. in Public School 73 from Gillis & Geoghagan, 527 West Bway., $191,485; E. Reutzler Co., $193,976; J. C. Williams, 261 West 126th St., $197,447.

N. Y., Buffalo—The Buffalo City Service Corp. plans to construct an electric plant and distribute electrical energy in Buffalo, Niagara Falls, Lockport, Lackawanna, Batavia, Rochester, Jamestown, Syracuse, Dunkirk and other western New York municipalities. E. C. Randall, Iroquois Bldg., is interested.

N. Y., Creedmore L. I. (Jamaica P. O.)—The U. S. Government, Wash., D. C., plans to construct several hospital buildings here. A steam heating system will be installed in same. About $3,000,000.

N. Y., New York—The French Hospital, 450 West 34th St., plans to build a 7 story, 100 x 100 ft. hospital and Nurses Home, including a steam heating system, at 441 West 33rd St. C. P. Gilbert, 1 Madison Ave., Archt. and Engr.

N. Y., New York—The United Electric Light & Power Co., 130 East 15th St., will soon award the contract for a power house on 134th St. and the East River. About $4,500,000.

N. Y., Ossining—Charles F. Rattigan, Supt. of Prisons, Capitol, Albany, will receive bids until December 6 for a death house including a steam heating system at the Sing Sing prison, here. About $325,000. L. F. Pilcher, Hall of Records, New York City, Archt. and Engr.

N. Y., Rochester—The State Bd. of Armory Comrs., Capitol, Albany, will receive bids until November 11 for the installation of a steam heating system and equipment in the Cavalry Armory on Culner Rd., here. Captain John Coffey, Secy.

N. Y., Yonkers—The Bd. Educ., High School Bldg., plans to build a high school including a steam heating system. About $300,000. J. H. Claxton, Secy.

Pa., Harrisburg—The Penn Harris Hotel, 3rd and Walnut Sts., plans to build a 12 story, 50 x 200 ft. hotel addition including a steam heating system, W. L. Stoddart, 9 East 40th St., New York City, Engr.

Pa., Johnstown—The Johnstown Sanitary Dairy Co. plans an election December 10 to vote on an increase of stock from $100,000 to $300,000., to purchase the plant of the Sanitary Ice Cream & Cold Storage Co. and build an addition to same. W. D. Gerber, Pres.

Pa., Philadelphia—The Nazel Eng. & Machine Wks., 4041 North 5th St., is in the market for one 20 hp. general electric motor.

Md., Baltimore—The City received the lowest bid for a 3 story, 46 x 150 ft. public school including a vapor heating plant, etc. on Laurens and Calhoun Sts., from J. L. Robinson Constr. Co., 1130 West Lafayette Ave., $322,582.

W. Va., Parkersburg—The Monongahela Valley Traction Co., 16th St., plans to double the capacity of its large power plant here by making improvements and additions to the machinery and equipment including a 5,000 kw. turbine and new boilers with automatic stoker equipment.

Ga., Trion—The Trion Co. will soon award the contract for a 3 story, 25 x 40 ft. power house addition. Jackson & Moreland, 387 Washington St., Boston, Mass., Engrs. Noted Oct. 12.

Fla., Jacksonville—The H. J. Lynch & Son, Archts., Dolph Bldg., St. Louis, Mo., will receive bids about November 15 for remodeling the old peoples home, installing heating and plumbing and constructing 3 additions to boiler plant including two high pressure boilers, for the Natl. Benevolent Association. About $75,000. Noted July 7.

Ky., Harrodsburg—The proposition to install a municipal electric light and power plant and water supply system at a cost of $200,000 will be submitted to the voters at an election to be held November 2. The power plant installation will consist of three 72 in. x 18 ft. high pressure boilers, one 350 hp. engine, one 200 kw., 2,300 volt 3 phase, 60 cycle generator, two 200 hp. engines, direct connected to two 100 kw. generators. The design is in charge of Greeley, Pearce & Hansen, 39 West Adams St., Chicago.

O., Ashtabula—The Bd. Educ. received bids for the construction of a 2 story school including a steam heating system, from the Moore Lamb Co., 202 Stambaugh St., Youngstown, $273,000; George Kratt, Lorain, $278,000.

O., West Park—The Bd. Educ. plans to build two 3 story grade schools including a steam heating system. About $1,000,000. F. W. Featherstone, Clk.

O., Youngstown—The Stambaugh Memorial Association, Dollar Bank Bldg., plans to build a 300 x 300 ft. civic auditorium. About $1,000,000.

Ind., Fort Wayne—The International Harvester Co. is having plans prepared for a 1 and 2 story manufacturing plant including a steam heating system on Pontiac St. About $2,000,000. Day & Zimmerman, 611 Chestnut St, Philadelphia, Pa., Engrs.

Mich., Ann Arbor—S. E. Remey and C. M. Agree, Archts., Whitney Office Bldg., Detroit, plans to build a 4 story, 60 x 200 ft. dormitory building including a steam heating system. About $175,000. Owner's name withheld.

Mich., Detroit—The Michigan Stamping Co., Mack and R.R. Sts., is in the market for 1 air compressor, belt or direct connected, capacity 700 cu.ft. per min. (new).

Mich., Oxford—H. V. Rahm, Village Clerk will receive bids until November 16 for furnishing and installing two 350 gal. per min., centrifugal domestic service pumps, 70 lbs. pressure, 30 hp., a.c. motor and one centrifugal fire pump, capacity, 750 gal. per min., 100 lbs. pressure, 75 hp., a.c. motor.

Ill., Chicago—Isaiah Temple, c/o Dr. J. Stolz, 4714 Grand Blvd., plans to build a temple and community house on 51st and Greenwood Ave. About $500,000.

Ill., Lincoln—The Lincoln Water & Light Co. plans to expend $60,000 for improvements, to include the installation of a 650 kw. General Electric turbo-generator, also an addition of a switchboard and boiler, not yet contracted for.

Wis., Hudson—The Burkhardt Milling & Electric Co., Burkhardt, plans to build an 18 x 23 ft. power house and repair dam on the Willow River. Holland, Ackerman & Holland, Inc., Monadnock Bldg., Chicago, Engrs.

Wis, Madison—The Sheboygan Dairy Products Co., 936 North Water St., plans to rebuild its 2 story, 60 x 150 ft. dairy products factory on West Wilson St. which was recently destroyed by fire. About $100,000. M. G. Douma, Secy.

Wis., Stevens Point—The Stevens Point Water Co., 526 North 8th St., Manitowoc, plans to improve water and pump station, here. Equipment will be installed in same. T. W. Gray, Mgr.

Wis., Tomahawk—The Tomahawk Pulp & Paper Co. is having plans prepared for several industrial buildings including a 50 x 354 ft. main building, 37 x 136 ft. engine room, 47 x 98 ft. boiler room containing 3 stoker type boilers and a 50 x 231 ft machine shop.

Minn., Aitkin—The Bd. of County Comrs. plans to build a court house including a steam heating system. About $250,000.

Minn., Minneapolis—Kirchhoff & Rose., Archts. and Engrs., Majestic Bldg., Milwaukee, Wis., will soon award the contract for a 2 and 3 story, 115 x 180 ft. theatre on Hennepin Ave., for Martin Beck, 1564 Bway., New York City. About $500,000.

Minn., Minneapolis—The State Bd. of Control, Capitol, St. Paul, is having plans prepared for a 4 story, 400 x 400 ft. library including a steam heating system on the State University Campus here. About $1,000,000. C. H. Johnston, 715 Capital Bank Bldg., St. Paul, Archt.

Minn., Northfield—Carleton College plans to build 11 college buildings including a steam heating system. About $3,150,000. D. J. Cowling, Pres.

Minn., Osakis—C. H. Millard, City Clk., will soon receive bids for the construction of a pumping station and the installation of equipment. About $10,000. C. L. Pillsbury Co., 805 Metropolitan Life Bldg., Minneapolis, Engr.

Minn., St. Paul—The Diocese of St Paul is conducting a campaign to raise $5,000,000 for schools and colleges. The building plans include the construction of a power house at the college of St. Thomas, Mernan Park.

Kan., Wichita — The Standing Grain Thresher Co., Union Natl. Bank Bldg., plans to build a thresher factory here. About $250,000. C. S. Gibbens, Nickerson, Secy.

Tex., Dallas—The Oriental Rug. Co., 3907 Ross Ave., is in the market for a 15 hp. or more two phase electric motor (new or second hand.)

Tex., Hubbard—The Union Central Light & Power Co. is in the market for a 100 ft. x 6 in. cotton spiral conveyor, also sprocket wheels, shafting, etc., for operating same (new or second hand.)

Okla., Tulsa—The city is having preliminary plans prepared for 6 additional filter units, 10,000,000 gal. basin, two 300 hp. boilers, etc. About $350,000. Halway Eng. Co., 230 Lynch Block, Engr.

Cal., Mare Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until November 10 for installing a heating system in the structural shop here.

Ont., Hamilton—The Provincial Bd. of Health has ordered the construction of an isolation hospital to cost between $750,000 and $900,00. X-ray equipment and a steam heating system will be installed in same. J. H. Pratt, Chn.

Ont., Kingston—The city plans to build an 8 or 10 story hotel including a vacuum steam heating system. About $450,000.

Ont., Ottawa—The Royal Securities Corp. and Harris Forbes & Co. plan to purchase $1,200,000 bonds of the Ottawa Light, Heat & Power Co. The proceeds of this issue will be utilized for the development of waterpower. T. Ahearn, Pres.

Ont., St. Catharines—The Bd. Educ. plans to build a 3 story collegiate institute. A vacuum steam heating system with an electrically operated mechanical ventilation system will be installed in same. About $400,000.

Ont., Toronto—The Welland Automobile Storage Battery Co., East 131st St. and St. Clair Ave., Cleveland, has purchased a 3 acre site on Weltshire Ave. and plans to construct a storage battery plant on same. About $500,000.

Ont., Windsor—The Bd. Educ. plans to construct a school including a steam heating and an electrically operated ventilation system. About $550,000.

CONTRACTS AWARDED

Mass., Brookline (Boston P. O.)—Charles A. Newhall, 1105 Tremont Bldg., Boston, will build an 8 story apartment hotel including a steam heating system on Beacon and St. Paul Sts. About $1,500,000. Work will be done by day labor.

Mass., Danvers—The Comn. on Mental Diseases, 36 State House, Boston, has awarded the contract for a 1 story, 57 x 137 ft. power plant at the State Hospital here, to the E. H. Porter Co., 13 Wallis St., Peabody, at $250,000. Noted Oct. 12.

Mass., Lynn—The Universal Tide Power Co., 69 Canal St., Boston, has awarded the contract for a hydraulic dam, to M. Seretto, 3 Tremont Row, Boston, at $300,000.

Mass., New Bedford—The Bd. Educ. has awarded the contract for the installation of a heating system in the proposed 2 story school on Mt. Pleasant St., at $74,371 and in the proposed 2 story, 170 x 250 ft. school on Rochambeau St., at $74,371 to M. A. Dame & Son Co., 90 Monroe St., Lynn. Noted Oct. 5.

Mass., South Hadley Falls (Holyoke P. O.)—The Hampshire Paper Co. has awarded the contract for altering the 1 story boiler house, to the S. M. Green Co., 293 Bridge St., Springfield, at $25,000.

Mass., Wrentham—The Commonwealth of Massachusetts, c/o Kendall, Taylor & Co., Archts., 93 Federal St., Boston, has awarded the contract for a 1 story, 50 x 70 ft. cold storage building at the State School here, to J. A. Munroe, Washington St., North Attleboro, at $50,000. Noted Oct. 12.

R. I., Providence—The city has awarded the contract for installing a steam heating system in the proposed 2 story school on Arthur Ave., to E. J. Sullivan, 87 Brook St.

N. Y., Brooklyn—The Colonial Mantle & Refrigerating Co. will build a 1 story, 40 x 100 ft. addition to its factory including a steam heating system at 494 Damont Ave. About $40,000. Work will be done by day labor.

N. Y., New York—The Seneca Holding Corp., 485 5th Ave., will alter the New York and Criterion theaters on Bway. and 45th St. About $500,000. Work will be done by day labor.

Pa., East Pittsburgh (Pittsburgh P. O.)—The Bd. Educ. has awarded the contract for a 2 story, 111 x 139 ft. school including a steam heating system, to the Hodder Constr. Co., Braddock, at $300,000.

Pa., Philadelphia—The General Carbonic Co., 847 North 3rd St., has awarded the contract for altering the present 1 story factory and boiler house to the Austin Co., Bulletin Bldg., at $10,000.

Fla., St. Petersburg—The H. R. McChesney Syndicate, Pittsburgh, Pa., has awarded the contract for a hotel including a steam heating system, to G. A. Fuller Co., 175 5th Ave., New York City, at $1,500,000.

Tenn., Chattanooga—The Mutual Enamel Wks. Co. has awarded the contract for a foundry and plant including a steam heating system, to D. P. Robinson, 125 East 46th St., New York City, at $800,000.

Mich, Detroit—The Detroit Packing Co., 40 Bushey St. has awarded the contract for a 2 story packing plant including a steam heating system on Springwells Ave., to the Patterson Constr. Co., 907 Ford Bldg., at $50,000.

Wis., Manitowoc—George Bros., 913 South 8th St., has awarded the sub-contract for the installation of a steam heating system in the proposed 3 story, 60 x 250 ft. theater on South 8th St., to G. H. Kallies. Noted Jan. 6.

Minn., Duluth—The Bd. Educ. has awarded the contract for a 2 story, 150 x 150 ft. school including a steam heating system on 28th Ave., East and 4th St., to McLeod & Smith, Sellwood Bldg., at $396,300.

Minn., Minneapolis—The State Bd. of Control, Capitol, St. Paul, has awarded the contract for the installation of a heating, plumbing, ventilation and vacuum systems in the proposed 3 story addition to the chemistry building at the State University here, to M. J. O'Neil, 608 Exch. Bank Bldg., St. Paul, at $125,000. Noted August 3.

Minn., Sabin—The Village has awarded the contract for materials for an 18 mi. high tension transmission line from here to a point near Fargo, N. D., and for electric distribution system here, including meters, transformers, etc., to the St. Paul Electric Co., 145 East 5th St., St. Paul, at $25,000.

N. D. Hankinson—The city has awarded the contract for the construction of a water system to include two 500 gal. fire pumps, 2 deep well pumps, etc., to W. D. Lovell, 1415 S.E. 8th St., Minneapolis, at $151,000.

Ont., Elmira—The Elmira Creamery Co. has awarded the contract for a 2 story, 80 x 92 ft. addition to its creamery, to Charles Wilken at $100,000. A boiler and other equipment will be installed in same.

Ont., Smooth Rock Falls—The Mattagami Pulp & Paper Co. has awarded the contract for a 2 story pulp mill and store building including a steam heating system, to Carter, Halls, Aldinger & Co., Union Bank Bldg., Winnipeg at $490,000.

"SEARCHLIGHT" is the "OPPORTUNITY"

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For Every Business Want

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PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft. Lengths
Underwriters' 2½-in.		85c. per ft.
Common, 2½-in.		30%

	Air		
	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.60	$0.40	$0.30

Steam—Discounts from List

First grade..... 20% Second grade.....30% Third grade....45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 50% Best grade..... 20%
Standard..... 30–10%

LEATHER BELTING—Present discounts from list in fair quantities (½ doz. rolls):

Light Grade	Medium Grade	Heavy Grade
30%	25%	20%

RAWHIDE LACING { For cut, best grade, 25%, 2nd grade, 30%. / For laces in sides, best, 79c per sq. ft.; 2nd, 75c. / Semi-tanned: cut, 20%; sides, 83c per sq. ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$1.00
Asbestos for high-pressure steam	1 70
Duck and rubber for piston packing	1 00
Flax, regular	1 20
Flax, waterproofed	1 70
Compressed asbestos sheet	.90
Wire insertion asbestos sheet	1 50
Rubber sheet	.50
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1 30
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are part of standard lists, with discounts.

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure..... List +5%

For low-pressure heating and return lines { 4-ply..... 50% off / 3-ply..... 52% off / 2-ply..... 54% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	8½	6.6	8@ 9	8½	13½
Fiber or sponge	8½	8.6	12@15	8½	20
Transmission	10	8.1	12@15	8½	20
Axle	..	4.8	6@ 6½	5½	7½
Gear	6½	6.1	8@9	5½	8½
Car journal	12(gal.)	4 7	23@25	8½	8½

COTTON WASTE—The following prices are in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
White	15.00@17.00	13.00	16.00	11.00 to 14.00
Colored mixed	9.00@14.00	9 00 to 12.00	12.00	9.50 to 12 00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	$55.00	$65.00
Chicago	41.00	43.50

LINSEED OIL—These prices are per gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$1.15	$1.75	$1.25	$1.92
5-gal. cans	1.30	1.90	1.50	2.07

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current Dry and In Oil	1 Yr. Ago Dry and In Oil
	Dry	In Oil	Dry	In Oil		
100-lb. keg	15.50	17.00	13.00	14.50	15.50	13.00
25- and 50-lb. kegs	15.75	17.25	13.25	14.75	15.75	13.25
12½-lb. keg	16.00	17.50	13.50	15.00	16.00	13.50
1-lb. cans	18.50	20.00	15.00	16.50	15.00	15.00
5-lb. cans	20.50	22.00	16.00	17.50	16.00	16.00

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅜ and smaller	List net	40%	30%
Tinned	List net	40%	30%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York.....$6.00 Chicago.....$5.73 Pittsburgh.....$4 50

Structual rivets, same sizes:

New York.....$7.10 Chicago.....$5.83 Pittsburgh.....$4 60

REFRACTORIES—Prices in carlots:

Bauxite brick, 56% alumina, f.o.b. Pittsburgh	per 1000	$160
Chrome brick, eastern Shipping points	net ton	100@$110
Chrome cement, 40@45% Cr_2O_3	net ton	55@ 60
Chrome cement, 40@45% Cr_2O_3, in sacks	net ton	60@ 65
Clay brick, 1st quality, fire clay, 9-in. shapes, Pennsylvania, Ohio and Kentucky	per 1000	55@ 60
Clay brick, 2d quality, fire clay, 9-in. shapes Pennsylvania, Ohio and Kentucky	per 1000	45@ 50
Magnesite brick: 9-in. straight	net ton	110
Magnesite brick: 9-in. arches, wedges and keys	net ton	121
Magnesite brick: Soaps and splits	net ton	134
Silica brick: Chicago district	per 1000	65@ 70
Silica brick: Birmingham, Ala	per 1000	56@ 61
Silica brick: Mt. Union, Pa	per 1000	55@ 60

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	80.00	90.00	49.00	70.00	45.00	60.00
Commercial	40.00	50.50	19.50	16.50	11.00	13.00

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting or screw stock, per 100 lb. base	$6.36	$5.90	$6.00
Flats, square and hexagons, per 100 lb. base	6.86	6.40	6.50

SHEETS—Quotations are in cents per pound in various cities from warehoues also the base quotations from mill:

	Large Mill Lots	New York			
Blue Annealed	Pittsburgh	Current	One Year Ago	Cleveland	Chicago
No. 10	3.55–7.00	7.25@ 8.00	4.57	6.75	7.13
No. 12	3.60–7.05	7.30@ 8.05	4.62	6.80	7.18
No. 14	3.65–7.10	7.35@ 8.10	4.67	7.35	7.23
No. 16	3.75–7.20	7.45@ 8.20	4.77	7.45	7.33
Black					
Nos. 18 and 20	4.20–6.20	8.40@ 9.80	5.30	8.30	7.90
Nos. 22 and 24	4.25–6.25	8.45@ 9.85	5.35	8.35	7.95
No. 26	4.30–6.30	8.50@ 9.90	5.40	8.40	8.00
No. 28	4.35–6.35	8.60@10.00	5.50	8.50	8.10
Galvanized					
No. 10	4.70–8.00	8.90@11.00	5.75	8.50	8.25
No. 12	4.80–8.10	9.00@11.00	5.85	8.60	8.30
No. 14	4.80–8.10	9.00@11.10	5.85	8.60	8.45
Nos. 18 and 20	5.10–8.40	9.25@11.40	6.15	8.90	8.75
Nos. 22 and 24	5.25–8.55	9.40@11 55	6.30	9.05	9.15
No. 26	5.40–8.70	9.55@11.70	6.45	9.20	9.30
No. 28	5.70–9.00	9.85@12.00	6.75	9.50	9.60

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card:

BUTT WELD

Steel			Iron		
Inches	Black	Galv.	Inches	Black	Galv.
¾ to 3	54 to 57½	41½ to 44	⅜	15½ to 25½	+1½ to 11
			½	19½ to 29½	1½ to 11½
			¾ to 1½	24½ to 34½	8 to 18½

LAP WELD

2	47 to 50½	34½ to 38	2	20½ to 28½	6½ to 14½
2½ to 6	50 to 53½	37½ to 41	2½ to 6	22½ to 30½	9½ to 17½
7 to 12	47 to 50½	33½ to 37	7 to 12	19½ to 27½	6½ to 14½
13 and 14	37½ to 41				
15	35 to 38½				

BUTT WELD, EXTRA STRONG, PLAIN ENDS

¼ to 1½	52 to 55½	39½ to 43	¾ to 1½	24½ to 34½	9½ to 19½
2 to 3	53 to 56½	40½ to 44			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	45 to 48½	33½ to 37	2	21½ to 29½	8½ to 16½
2½ to 4	48 to 51½	36½ to 40	2½ to 4	23½ to 31½	11½ to 19½
4½ to 6	47 to 50½	35½ to 39	4½ to 6	22½ to 30½	10½ to 18
7 to 8	43 to 46½	29½ to 33	7 to 8	14½ to 22½	2½ to 10½
9 to 12	38 to 41½	24½ to 28	9 to 12	9½ to 17½	5½ to+2½

BOILER TUBES—The following are the prices for carload lots, f.o.b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	15 to 40½	1¼ and 1½ in.	+20
2½ to 3¼ in.	10 to 30½	2 and 2½ in.	+10
2¼ in.	4 to 24	2¼ and 2¾ in.	+1
1¼ to 2 in.	+½ to—19½	3 and 3½ in.	—1½
		3½, 4 and 4½ in.	—8

Standard Commercial Seamless — Cold Drawn or Hot Rolled

Per Net Ton		Per Net Ton	
1 in.	$327	1¼ in.	$207
1¼ in.	267	2 to 2½ in.	177
2¼ in.	257	2¾ to 3½ in.	167
1½ in.	207	4 in.	187
		4½ to 5 in.	207

ELECTRICAL SUPPLIES

ARMORED CABLE—

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 95.00(net)	$138.00	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

Less than coil lots	+ 5%	+15%
Coils to 1,000 ft.	— 5%	List Net
1,000 ft. and over	—10%	7%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever-Ready:

	Each, Net
Less than 12	$0.48
12 to 50	.41
50 to 125 (bbl.)	.38
125 (bbl.) or over	.35

CONDUIT, Price per 1000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f. o. b. New York with 10-day discount of 5 per cent.

	Conduit		Elbows		Couplings	
Size, In.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.
¼	85.66	90.39	20.20	21.34	6.38	6.74
⅜	113.62	119.99	26.58	27.83	7.44	7.85
½	167.96	177.38	39.35	41.56	10.63	11.23
¾	227.24	239.98	50.10	52.80	13.82	14.60
1	271.70	286.93	66.80	70.40	18.93	19.95
1¼	365.56	386.06	122.47	129.07	23.38	24.64
1½	577.98	610.39	200.41	211.21	31.18	32.85
2	755.82	798.20	534.43	563.23	44.53	46.94
2½	936.38	987.52	1,180.20	1,243.80	66.80	70.40
3	1,131.20	1,191.81	1,363.91	1,437.41	89.07	93.87

CONDUIT NON-METALLIC, LOCM—

Size I. D., In.	Feet per Coil	List, Ft.
⅜	250	$0.05½
½	250	.06
¾	250	.09
1	200	.12
1¼	200	.15
1½	150	.18
2	100	.25
2½	100	.33
3	Odd lengths	.40
4	Odd lengths	.55

1000 ft. and over.... 40% off
Coils..... 30% off
Less coils, 20% off

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.43
D. P. M. L.	.21	T. P. to D. P. S. B.	.26
T. P. M. L.	.33	T. P. S. B.	.38
D. P. S. B.	.23	T. P. D. B.	.64

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.50	$1.30	$1.68
T. P. M. L.	.70	1.70	2.40
D. P. S. B.	.63	1.60	.....
T. P. S. B.	1.15	2.40	.....
D. P. D. B.	1.10	3.00	.....
T. P. D. B.	1.90	5.40	.....
T. P. to D. P. D. B.	1.30	3.80	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$25.00
No. 16 cotton twisted	29.00
No. 18 cotton parallel	32.00
No. 16 cotton parallel	39.50
No. 18 cotton reinforced heavy	43.00
No. 16 cotton reinforced heavy	50.00
No. 18 cotton reinforced light	37.50
No. 16 cotton reinforced light	43.00
No. 18 cotton Canvasite cord	30.00
No. 16 cotton Canvasite cord	33.50

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.25
35-amp. to 60-amp.	100	.35
65-amp. to 100-amp.	50	.90
110-amp. to 200-amp.	25	2.00
225-amp. to 400-amp.	25	3.60
425-amp. to 600-amp.	10	5.50

600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package 15%
1-5th to standard package 28%
Standard package 45%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$5.25C
0-30 ampere, less than standard package	6.00C

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs — Mazda B—				Pear-Shaped Bulbs — Mazda C—			
Watts	Plain	Frosted	No. in Package	Watts	Clear	Frosted	No. in Package
10	$0.40	$0.45	100	75	$0.75	$0.80	50
15	.40	.45	100	100	1.10	1.25	24
25	.40	.45	100	150	1.55	1.70	24
40	.40	.45	100	200	2.10	2.30	24
50	.40	.45	100	300	3.15	3.40	24
60	.45	.50	100				12
				500	4.60	4.90	12
				750	6.50	6.90	8
				1,000	7.50	7.95	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.28
Composition 2-piece attachment plug	.36
Swivel attachment plug	.20
Current taps	.45

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$11.00	$14.00	$16.50	$27.50
12	14.96	18.50	21.45	35.00
10	20.62	24.75	28.05	46.00
8	28.90	33.30	38.50	66.00
6	.....	.....	58.75	.....
4	.....	.....	80.75	.....
2	.....	.....	111.00	.....
1	.....	.....	154 00	.....
0	.....	.....	181.50	.....
00	.....	.....	220 00	.....
000	.....	.....	265 00	.....
0000	.....	.....	330.00	.....

Prices per 1000 ft. for Rubber-Covered Wire in Following Cities:

	Denver			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$13.50	$18.00	$34.10	$12.36	.....	$38.64
10	22.25	25.75	53.95	27.60	.....	48.30
8	28.75	33.50	80.00	38.74	.....	87.33
6	51.00	53.30	.....	.....	$77.34	.....
4	70.00	72.25	.....	.....	107.42	.....
2	98.00	100.00	.....	.....	138.46	.....
1	133.00	136.75	.....	.....	178.62	.....
0	197.00	197.05	.....	.....	217.09	.....
00	.....	.....	.....	.....	263.57	.....
000	.....	.....	.....	.....	320.44	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap			¾ In. Cap		
Key Each	Keyless Each	Pull Each	Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package +50%
1-5th to standard package +20%
Standard package —15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B. & S. regular spools (approx. 8 lb.)	55c. lb
No. 18 B. & S. regular 1-lb. coils	56c. lb

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 56c. lb., 100 lb. lots	52c. lb
Rubber tape, ¾ in., less 100 lb. 65c. lb., 100 lb. lots	60c. lb
Wire solder, less 100 lb. 47c. lb., 100 lb. lots	42c. lb
Soldering paste, 2 oz. cans	$1.50 doz

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	.70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	+25%
$10 to $25 list value	+10%
$25 to $50 list value	+ 5%
$50 to $200 list value	—10%
$200 list value or over	—15%